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# NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

REPORT No. 240

## NOMENCLATURE FOR AERONAUTICS

By NATIONAL ADVISORY COMMITTEE  
FOR AERONAUTICS



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By National Advisory Committee  
For Aeronautics

## NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

3341 NAVY BUILDING, WASHINGTON, D. C.

[An independent Government establishment, created by act of Congress approved March 3, 1915, for the supervision and direction of the scientific study of the problems of flight. It consists of 12 members who are appointed by the President, all of whom serve as such without compensation.]

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## INTRODUCTION

The nomenclature for aeronautics presented in this Report No. 240 is a revision of the last previous report on the subject (No. 157), which was issued in February, 1923.

This Nomenclature for Aeronautics was prepared by a special conference on aeronautical nomenclature authorized by the executive committee of the National Advisory Committee for Aeronautics at a meeting held on August 19, 1924, at which meeting Dr. Joseph S. Ames was appointed chairman of said conference. The conference was composed of representatives of the National Advisory Committee for Aeronautics, and, in response to the committee's invitation specially appointed representatives officially designated by the Army Air Service, the Bureau of Aeronautics of the Navy Department, the Bureau of Standards, the American Society of Mechanical Engineers, the Society of Automotive Engineers, and the Aeronautical Chamber of Commerce.

To facilitate the work of the conference the entire nomenclature was divided into four main sections, and a subcommittee was appointed to study and agree upon the terms for each section. These four subcommittees, with their officers, were as follows:

*Subcommittee on Aerodynamic Terms.*—Dr. Joseph S. Ames, chairman; Commander H. C. Richardson, United States Navy, vice chairman for airplanes and airplane parts; Dr. H. L. Dryden, vice chairman for aircraft instruments; and Prof. Edward P. Warner, vice chairman for maneuvers and general aerodynamics.

*Subcommittee on Airship Terms.*—Mr. Starr Truscott, chairman.

*Subcommittee on Power Plant Terms.*—Mr. G. W. Lewis, chairman.

*Subcommittee on Airway Terms.*—Lieut. St. Clair Streett, United States Army, chairman.

On completion of the reports of these four subcommittees, they were considered by the entire conference at a final meeting, and on recommendation of the conference the complete nomenclature was officially approved by the executive committee of the National Advisory Committee for Aeronautics on September 19, 1925.

This report supersedes all previous publications of the committee on this subject. It is published for the purpose of securing greater uniformity and accuracy in the use of terms relating to aeronautics, in official documents of the Government and, as far as possible, in technical and other commercial publications.

The organization of the conference on aeronautical nomenclature was as follows:

### CONFERENCE ON AERONAUTICAL NOMENCLATURE

Dr. JOSEPH S. AMES, *Chairman*

#### NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS:

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Prof. Edward P. Warner.  
Mr. Thomas Carroll.  
Mr. Marsden Ware.

#### AIR SERVICE OF THE ARMY:

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Capt. R. L. Walsh, U. S. A.  
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Dr. A. F. Zahm.  
Commander E. E. Wilson, U. S. N.  
Lieut. W. S. Diehl, U. S. N.  
Mr. Starr Truscott.

#### BUREAU OF STANDARDS:

Dr. H. C. Dickinson.  
Dr. H. L. Dryden.

#### AMERICAN SOCIETY OF MECHANICAL ENGINEERS:

Dr. W. F. Durand.

#### SOCIETY OF AUTOMOTIVE ENGINEERS:

Mr. Grover C. Loening (also representing Aeronautical Chamber of Commerce).

Mr. W. B. Stout.

Mr. R. H. Upson.

#### AERONAUTICAL CHAMBER OF COMMERCE:

Mr. S. S. Bradley.  
Mr. Ladislav d'Orey.  
Mr. George Mead.  
Mr. Arthur L. Nutt.  
Mr. Grover C. Loening (also representing Society of Automotive Engineers).

## 1. INTRODUCTION

The present study is a continuation of the work done in the previous paper (1) in which the effect of the concentration of the reactants on the rate of the reaction was investigated. In the present paper the effect of the temperature on the rate of the reaction is investigated. The reaction studied is the reaction between hydrogen peroxide and potassium iodide in the presence of ceric sulfate as a catalyst. The reaction is given by the following equation:

$$2H_2O_2 + 2KI \rightarrow 2H_2O + 2KOH + I_2$$

The reaction is catalyzed by ceric sulfate, which is reduced to cerous sulfate during the reaction. The rate of the reaction is measured by the appearance of iodine, which is detected by the formation of a blue color with starch. The rate of the reaction is measured at different temperatures and the effect of temperature on the rate is determined. The results show that the rate of the reaction increases with increasing temperature. The activation energy of the reaction is determined from the Arrhenius plot. The results show that the activation energy of the reaction is 15.2 kJ/mol.

## EXPERIMENTAL

The reaction was carried out in a 250 ml. Erlenmeyer flask. The reactants were weighed accurately and dissolved in distilled water. The ceric sulfate catalyst was added to the solution. The reaction was started by adding a small amount of potassium iodide. The time taken for the appearance of the blue color was measured. The experiment was repeated at different temperatures. The results are given in the following table:

Temperature (°C)	Time (sec)
20	120
25	80
30	50
35	30
40	15

# REPORT No. 240

## NOMENCLATURE FOR AERONAUTICS

By The NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

### PART I

#### ALPHABETICAL NOMENCLATURE

**absolute inclinometer**—See INCLINOMETER, ABSOLUTE.

**accelerometer**—An instrument for indicating, measuring, or recording accelerations.

**aerodynamic volume**—See VOLUME, AERODYNAMIC (AIRSHIP).

**aerodynamics**—The branch of dynamics which treats of the motion of air and other gaseous fluids and of the forces acting on solids in motion relative to such fluids.

**aeronautics**—The science and art pertaining to the flight of aircraft.

**aerostat**—A generic term for aircraft whose support is chiefly due to buoyancy derived from aerostatic forces. The immersed body consists of one or more bags, cells, or other containers, filled with a gas which is lighter than air.

**Syn.**—LIGHTER-THAN-AIR CRAFT. Includes airship and balloon, q. v.

**aerostatics**—The science that treats of the equilibrium of gaseous fluids and of solid bodies immersed in them.

As an aeronautic term, it relates to those properties of lighter-than-air craft which are due to the buoyancy of the air.

**aerostation**—The art of operating aerostats.

**aileron**—A hinged or pivoted movable auxiliary surface of an airplane, usually part of the trailing edge of a wing, the primary function of which is to impress a rolling moment on the airplane. (Fig. 1.)

**aileron angle**—See ANGLE, AILERON.

**air controls**—See CONTROLS.

**aircraft**—Any weight-carrying device or structure designed to be supported by the air, either by buoyancy or by dynamic action.

**air duct**—A tube, usually of fabric, supplying air for filling or for maintaining pressure in air-filled parts of an aerostat.

(a) The duct joining the vertical and lateral lobes of a kite balloon. Sometimes called "interconnecting sleeve" or "trousers" (British). (Fig. 2.)

(b) The duct leading from the air scoop or blower of a nonrigid or semirigid airship to the ballonnet or ballonets. (Figs. 2 and 5.)

**airfoil**—Any surface designed to be projected through the air in order to produce a useful dynamic reaction.

**airfoil section (or profile)**—A cross section of an airfoil made by a plane parallel to a specified reference plane. A line perpendicular to this plane is called the axis of the airfoil.

**air log**—An instrument for measuring the linear travel of an aircraft relative to the air. One form consists of a windmill with a revolution counter.

**airplane**—A mechanically driven aircraft, heavier than air, fitted with fixed wings, and supported by the dynamic action of the air. (Figs. 1, 6, 9, 10, and 14.)

**airplane, pusher**—An airplane with the propeller or propellers in the rear of the main supporting surfaces. (Figs. 9 and 14.)

**airplane, tandem**—An airplane with two or more sets of wings of substantially the same area (not including the tail unit) placed one in front of the other and on about the same level.

**airplane, tractor**—An airplane with the propeller or propellers forward of the main supporting surfaces. (Figs. 1, 6, and 10.)

**airport**—A locality, either of water or land, which is adapted for the landing and taking off of aircraft and which provides facilities for shelter, supply, and repair of aircraft; or a place used regularly for receiving or discharging passengers or cargo by air.

**air scoop**—A projecting scoop which uses the wind or slip stream to maintain air pressure in the interior of the ballonnet of an aerostat. (Figs. 2, 3, and 12.)

A similar device is sometimes used on airplanes to produce ventilation. (Fig. 4.)

**airship**—An aerostat provided with a propelling system and with means of controlling the direction of motion. When its power plant is not operating, it acts like a free balloon.

**nonrigid**—An airship whose form is maintained by the internal pressure in the gas bags and ballonets. (Fig. 3.)

**rigid**—An airship whose form is maintained by a rigid structure. (Fig. 4.)

**semirigid**—An airship whose form is maintained by means of a rigid or jointed keel in conjunction with internal pressure in the gas containers and ballonets. (Fig. 5.)

The term "airship" is sometimes incorrectly applied to heavier-than-air craft either in full or as "ship." This is a slang use of the word and should be avoided.

**airship dope**—See DOPE, AIRSHIP.

**airship station**—See STATION, AIRSHIP.

**air speed**—The speed of an aircraft relative to the air. Its symbol is  $V$ .

**air-speed meter**:

**air-speed indicator**—An instrument for indicating the speed of an aircraft relative to the air. It is actuated by the pressure developed in a suitable pressure nozzle or against a suitable obstruction and is graduated to give true air speed at a standard air density.

The speed indicated by the instrument is termed the "indicated air speed." (The indicated speed is a direct measure of the lift or drag exerted on the airplane at any altitude. Stalling at all altitudes occurs for the same value of the indicated speed.)

**true air-speed meter**—An instrument for measuring the true speed of an aircraft relative to the air. The Biram and Robinson anemometers are of this type.

**air volume (airship)**—See VOLUME, AIR (AIRSHIP).

**air-volume displacement**—See DISPLACEMENT, AIR VOLUME.

**airway**—An air route between air traffic centers which is over terrain best suited for emergency landings, with landing fields at intervals equipped with aids to air navigation and a communication system for the transmission of information pertinent to the operation of aircraft.

The term "airway" may apply to an air route for either landplanes or seaplanes or both.

**alarm, gas-cell**—A device, fitted adjacent to a gas cell, which indicates or warns when a pre-determined limiting pressure has been reached in the gas cell. Also called "pressure alarm."

**altigraph**—An altimeter equipped with a recording mechanism. Present instruments are of the aneroid type. The chart, driven by clockwork, is usually graduated in feet or meters in accordance with some empirical or arbitrary pressure-temperature-altitude formula. In other words, it is a barograph whose scale is designed to read heights.

**altimeter**—An instrument for measuring or indicating the elevation of an aircraft above a given datum plane.

**altimeter, aneroid**—An altimeter, the indications of which depend on the deflection of a pressure-sensitive element. The graduations of the dial correspond to an empirical or arbitrary pressure-temperature-altitude formula.

**altimeter, electrical-capacity**—An altimeter, the indications of which depend on the variation of an electrical capacity with distance from the earth's surface.

- altimeter, engine**—An altimeter for indicating the altitude corresponding to the pressure produced in the intake manifold of a supercharged engine.
- altimeter, optical**—An altimeter, the indications of which depend on the manipulation of a suitable optical system.
- altimeter, sound-ranging**—An altimeter, the indications of which depend on the measurement of the time required for a sound wave to travel from the aircraft to the earth and back.
- amphibian**—An airplane designed to rise from and alight on either land or water.
- anchor, sea**—An open fabric bag carried on an aircraft and arranged to offer considerable resistance when towed mouth-first through the water. Tripping or collapsing devices may be incorporated in it. Also called "drogue."
- anchorage, snatch-block**—An anchorage set in the ground for a snatch block used with a yaw line from a mooring mast. The anchorages may be of concrete or timber and are usually arranged at equal intervals around the circumference of a circle whose center is the mast; may also be applied to any anchorage for a snatch block used in hauling down an airship or kite balloon.
- anemometer**—An instrument for indicating or measuring the speed of an air stream.
- aneroid altimeter**—See **ALTIMETER, ANEROID**.
- angle, aileron**—The angular displacement of an aileron from its neutral position. It is positive when the trailing edge of the aileron is below the neutral position.
- angle, critical**—An angle of attack at which the flow about an airfoil changes abruptly with corresponding abrupt changes in the lift and drag.
- angle, downwash**—The angle through which an air stream is deflected by any lifting surface of an airplane. It is measured in a plane parallel to the plane of symmetry and is denoted by the symbol  $\epsilon$ .
- angle, drift**—The horizontal angle between the longitudinal axis of an aircraft and its path relative to the ground.
- angle, effective helix**—The angle of the helix described by a particular point on a propeller blade as the airplane moves forward through air otherwise undisturbed. It is equal to the angle whose tangent is the ratio of the velocity of flight to the product of the four quantities:  $2\pi$ ,  $r$  (the distance from the axis to the point in question) and  $n$  (the number of revolutions per second), i. e.,
- $$\Phi = \tan^{-1} \left( \frac{V}{2\pi rn} \right).$$
- angle, elevator**—The angular displacement of the elevator from its neutral position. It is positive when the trailing edge of the elevator is below the neutral position.
- angle, landing**—The acute angle between the line of thrust of an airplane and the horizontal when the airplane is resting on level ground in its natural position. Also called "ground angle." (Fig. 1.)
- angle, longitudinal dihedral**—The difference in angle of wing setting and of stabilizer setting. (This angle is positive when the angle of stabilizer setting, referred to the thrust line, is less than the angle of wing setting.)
- angle, minimum gliding**—The acute angle between the horizontal and the most nearly horizontal path along which an airplane can descend steadily in still air when the propeller is giving no thrust.
- angle of attack**—The acute angle between the chord of an airfoil and its direction of motion relative to the air. (This definition may be extended to other bodies than airfoils.) Its symbol is  $\alpha$ .
- angle of incidence of wing**—See **ANGLE OF WING SETTING**.
- angle of pitch**—The acute angle between two planes defined as follows: One plane includes the lateral axis of the aircraft and the direction of the relative wind; the other plane includes the lateral axis and the longitudinal axis. (In normal flight the angle of pitch is, then, the angle between the longitudinal axis and the direction of the relative wind.) This angle is denoted by  $\theta$  and is positive when the nose of the aircraft has risen.

- angle of roll, or angle of bank**—The acute angle through which an aircraft must be rotated about its longitudinal axis in order to bring its lateral axis into a horizontal plane. This angle is denoted by  $\Phi$  and is positive when the left wing is higher than the right.
- angle of stabilizer setting**—The acute angle between the line of thrust of an airplane and the chord of the stabilizer. (Fig. 1.)
- angle of wing setting**—The acute angle between the plane of wing chord and the line of thrust. It may differ for each wing. (Fig. 1.)
- angle of yaw**—The acute angle between the direction of the relative wind and the plane of symmetry of an aircraft. This angle is denoted by  $\Psi$  and is positive when the aircraft has turned to the right.
- angle, propeller-blade**—The acute angle between the chord of a propeller section and a plane perpendicular to the axis of rotation of the propeller. Usually called "blade angle."
- angle, rudder**—The acute angle between the rudder and the plane of symmetry of the aircraft. It is positive when the trailing edge has moved to the left with reference to the normal position of the pilot.
- angle, wing-dihedral or dihedral**—The acute angle between the transverse reference line in the wing surface and the lateral axis of the airplane projected on a plane perpendicular to the longitudinal axis. The dihedral angle is positive when the upper obtuse angle for the two wings is less than  $180^\circ$ . (Fig. 1.)
- angle, zero-lift**—The angle of attack of an airfoil when its lift is zero.
- antiflutter wire**—See WIRE (AIRSHIP), ANTIFLUTTER.
- apparatus, water-recovery**—Apparatus carried on an airship for condensing and recovering the water contained in the exhaust gases of internal combustion engines in order to avoid the necessity of valving gas as the fuel is consumed.
- appendix**—The tube, usually located at the bottom of a balloon, primarily used for inflation and deflation. In the case of a free balloon it may also serve as an automatic-discharge opening. (Fig. 11.)  
Originally applied to free balloons only. Should be restricted to the various types of balloons and not applied to airships.
- appendix manhole**—See MANHOLE, APPENDIX.
- apron**—A hard surface area of considerable extent immediately in front of the entrance of a hangar or aircraft shelter which is used for the handling of aircraft or for repair in clear weather.
- aspect ratio**—The ratio of span to mean chord of an airfoil; i. e., the ratio of the square of the maximum span to the total area of an airfoil.
- aspect ratio of propeller blade**—Half the ratio of propeller diameter to maximum blade width.
- attitude**—The position of an aircraft as determined by the inclination of its axes to some frame of reference. If not otherwise specified, this frame of reference is fixed to the earth.
- automatic valve**—See VALVE, AUTOMATIC.
- aviation**—The art of operating heavier-than-air craft.
- axes of an aircraft**—Three fixed lines of reference, usually centroidal and mutually perpendicular. The longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller, is called the longitudinal axis; the axis perpendicular to this in the plane of symmetry is called the normal axis; and the third axis perpendicular to the other two is called the lateral axis. In mathematical discussions, the first of these axes, drawn from front to rear, is called the  $X$  axis; the second, drawn upward, the  $Z$  axis; and the third, running from right to left, the  $Y$  axis.
- axial cable**—See CABLE, AXIAL.
- axial cone**—See CONE, AXIAL.
- bag, gas**—See HULL (AIRSHIP), and CELL, GAS, which are to be preferred, according to the type and use.

- balanced surface**—A control surface which extends on both sides of the axis of the hinge or pivot in such a manner as to reduce the moment of the air forces about the hinge. (Figs. 1, 3, 4, and 5.)
- ballast**—Any substance, usually sand or water, carried in a balloon or airship and intended to be thrown out, if necessary, for the purpose of reducing the load carried and thus altering the aerostatic relations. (Figs. 4 and 5.)
- ballonet**—A compartment of variable volume constructed of fabric, or partitioned off, within the interior of a balloon or airship. It is usually partially inflated with air, under the control of valves, from a blower or from an air scoop. By the blowing in or letting out of air, it serves to compensate for changes of volume in the gas contained in the envelope and to maintain the gas pressure, thus preventing deformation or structural failure. By means of two or more ballonets, often used in nonrigid airships, the trim can also be controlled. The ballonet should not be confused with gas cell. (Figs. 2, 3, and 5.)
- ballonet diaphragm**—See DIAPHRAGM, BALLONET.
- ballonet-fullness indicator**—See INDICATOR, BALLONET-FULLNESS.
- balloon**—An aerostat without a propelling system.
- barrage**—A small captive balloon, used to support wires or nets which are intended as a protection against attacks by aircraft.
- captive**—A balloon restrained from free flight by means of a cable attaching it to the earth.
- constant pressure\***—A supply balloon arranged to maintain a constant pressure of gas in a moored or docked aerostat.
- free**—A balloon, usually spherical, whose ascent and descent may be controlled by use of ballast or with a loss of the contained gas, and whose direction of flight is determined by the wind. (Fig. 11.)
- kite**—An elongated form of captive balloon, fitted with lobes to keep it headed into the wind and usually deriving increased lift due to its axis being inclined to the wind. (Fig. 2.)
- nurse\***—Sometimes used to refer to a constant-pressure balloon.
- observation**—A captive balloon used to provide an elevated observation post.
- pilot\***—A small balloon sent up to show the direction and speed of the wind.
- propaganda**—A small free balloon sent up without passengers but with a device by which papers or documents may be dropped at intervals.
- sounding\***—A small balloon sent up without passengers but with recording meteorological instruments.
- supply\***—A container made of heavy fabric employed as a portable means of storing gas at low pressure. It is usually too heavy to rise, even if free.
- triangulation\***—A small captive balloon used as a mark on which to sight in a triangulation survey.
- balloon bed**—A mooring place on the ground for a captive balloon.
- balloon fabric**—See FABRIC, BALLOON.
- band:**
- drip**—See FLAP, DRIP.
- mooring**—A band of tape or webbing, over the top of a kite balloon, to which the mooring ropes are attached. It forms part of a mooring harness. (Fig. 2.)
- suspension**—A horizontal fabric band, securely fastened to the envelope of a balloon or airship, and to which are attached the main suspensions of the basket or car, or the captive cable of a kite balloon. (Fig. 2.)
- trajectory**—A band of webbing carried in a special curve over the surface of the envelope of an airship to distribute the stresses due to the suspension of the car. (Fig. 13.)

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\* Those forms of balloons marked with an asterisk (\*) are not, strictly speaking, aircraft.

**bank**—To incline an airplane laterally, i. e., to rotate it about its longitudinal axis. Right-bank is to incline the airplane with the right wing down.

Also used as a noun to describe the position of an airplane when its lateral axis is inclined to the horizontal.

**bank, angle of**—See ANGLE OF ROLL.

**barograph**—An instrument for recording the barometric or static pressure of the atmosphere.

**barrage balloon**—See BALLOON, BARRAGE.

**barrel-type engine**—See ENGINE, BARREL-TYPE.

**bar, suspension**—A bar to which the supporting ropes of the basket of a balloon are secured. It is also fitted with ropes and toggles for attaching to the basket suspensions from the balloon. Also called "trapeze bar." (Figs. 2 and 11.)

**basic load**—See LOAD, BASIC.

**basket**—The structure suspended beneath a balloon, for carrying passengers, ballast, etc. (Figs. 2 and 11.)

It is usually used on a free or kite balloon.

**batonet**—A special form of toggle, usually quite slender and truly cylindrical, except for the groove, and used to attach the rigging of a balloon or airship to a fabric loop or suspension band on the envelope.

**bay (body parts)**—The portion of a face of a truss, or of a fuselage, between adjacent bulkheads or adjacent struts or frame positions.

**biplane**—An airplane with two main supporting surfaces placed one above the other. (Fig. 1.)

**blade back**—The side of a propeller blade which corresponds to the upper surface of an airfoil.

**blade face**—The surface of a propeller blade which corresponds to the lower surface of an airfoil. Sometimes called "thrust face," or "driving face."

**blade-width ratio**—The ratio of the developed width of a propeller blade at any point to the circumference of a circle whose radius is the distance of that point from the propeller axis.

**blimp**—A small nonrigid airship. "Airship" is to be preferred.

**body**—The fuselage or hull, or nacelle (including cowlings and covering) and nacelle mounting. (Figs. 1, 6, 9, 10, and 14.)

**bonnet**—See HOOD, VALVE.

**bow cap**—See CAP, BOW.

**bow-heavy**—The condition of an airship which, when at rest in still air, trims with its axis inclined down by the bow. The term "bow-heavy" is preferred to "nose-heavy" in describing airships.

**bow-steadying line**—See LINE, YAW.

**bow stiffener**—See STIFFENER, BOW.

**box girder**—See GIRDER, BOX.

**brake mean effective pressure**—The net unit pressure which, if applied during the power strokes to the pistons of an engine having no mechanical losses, would produce the given brake horsepower at the stated speed.

**breathing**—The passage of air into or out of an aerostat, due to the changing of its volume.

**breathing stresses**—See STRESSES, BREATHING.

**bridle**—A sling of cordage or wire which has its ends fixed at two different points, to the bight of which a single line may be attached, either movable or fixed, thus distributing the pull of the single line to two points or more in the case of a multiple bridle. This term is also used to refer to a towing or mooring line having two legs and intended to reduce yawing when towing or mooring.

**building cradle**—See CRADLE, BUILDING.

**bullseye**—A circular thimble.

**buoyancy**—The upward air force on an aerostat which is derived from aerostatic conditions. It is equal to the weight of the air displaced.

**buoyancy, center of (aerostat)**—The center of gravity of the volume of the contained gas.

**cabane**—A framework for supporting the wings at the fuselage; also applied to the system of trussing used to support overhang in a wing. (Figs. 6, 9, and 10.)

- cable, axial**—The axial member (usually steel wire cable) sometimes fitted in a rigid airship. It is attached to the central fitting of the radial or diametral wires of each main transverse and to the hull structure at bow and stern. Its purpose is to provide support for the radial or diametral wires in an axial direction and thus assist them to sustain the load which might be caused by unequal pressure in adjacent cells or by the airship being pitched to a large angle. (Fig. 4.)
- camber**—The rise in the curve of an airfoil section from its chord, usually expressed as the ratio of the departure of the curve from the chord to the length of the chord. "Upper camber" refers to the upper surface of an airfoil and "lower camber" to the lower surface; "mean camber" is the mean of these two.
- capacity**—The volume of the gas-containing portion of an aerostat.
- capacity, nominal gas**—The volume of the envelope of gas cells of an aerostat under certain conditions of pressure and inflation which have been defined. It is rarely the same as the true full volume. This is usually very difficult to determine accurately, especially in the case of rigid airships. Sometimes called "volume."
- cap, bow**—(1) A cap of metal or fabric used to reinforce the extreme forward ends of the bow stiffeners of a nonrigid or semirigid airship. (Figs. 3 and 5.)  
(2) The conical or cap-shaped structure at the extreme bow of a rigid airship to which the longitudinal girders are attached and which supports the bow mooring spindle. (Fig. 4.)
- cap, nose**—See CAP, BOW, which is to be preferred.
- captive balloon**—See BALLOON, CAPTIVE.
- car**—That portion of an airship which is intended to carry power unit or units, personnel, cargo, or equipment. It may be suspended from the buoyant portion, or it may be built close up against it. It is not to be applied to parts of the keel of a rigid or semirigid airship which have been fitted for the purposes mentioned. (Figs. 3, 4, 5, 12, and 13.)
- car, control**—The car of an airship in which controls are centralized and from which it is operated. (Figs. 3, 4, 5, 12, and 13.)
- carrier, fin**—A frame to which the inboard edge of the fin of a nonrigid or semirigid airship is attached, so as to prevent the edge of the fin from sinking into the envelope. (Fig. 5.)
- car, side**—See CAR, WING.
- car, wing**—A car suspended off the center line of an airship. It is also called "side car." (Fig. 4.)
- catenary**—A line or length of cordage which is secured to or in a piece of fabric in the form of a catenary curve or a series of such curves. (Fig. 5.)
- ceiling**:
- absolute**—The maximum height above sea level at which a given airplane would be able to maintain horizontal flight, assuming standard air conditions.
- service**—The height above sea level, assuming standard air conditions, at which a given airplane ceases to be able to rise at a rate higher than a small specified one (100 feet per minute in the United States and England). This specified rate may be different in different countries.
- ceiling, static**—The altitude in standard atmosphere, at which an aerostat is in static equilibrium after removal of all dischargeable weights.
- cell, gas**—One of the gas-containing units fitted in a rigid airship. Sometimes called "gas bag." (Fig. 4.)
- center of buoyancy**—See BUOYANCY, CENTER OF (AEROSTAT).
- center of pressure coefficient**—The ratio of the distance of the center of pressure from the leading edge to the chord length.
- center of pressure of an airfoil section**—The point in the chord of an airfoil section, prolonged if necessary, which is at the intersection of the chord and the line of action of the resultant air force. Its abbreviation is *C. P.*
- chafing patch**—See PATCH, CHAFING.
- channel patch**—See PATCH, CHANNEL.

**chord** (of an airfoil section)—The line of a straight edge brought into contact with the lower surface of the section at two points; in the case of an airfoil having double convex camber, the straight line joining the leading and trailing edges. (These edges may be defined, for this purpose, as the two points in the section which are farthest apart.)

(Fig. 1.) The line joining the leading and trailing edges should be used also in those cases in which the lower surface is convex except for a short flat portion.

The method used for determining the chord should always be explicitly stated for those sections with regard to which ambiguity seems likely to arise.

**chord length**—The length of the projection of the airfoil section on its chord. Its symbol is  $c$ .

**chord, mean, of a combination of wings**—The ratio—

$$\frac{c_1 S_1 + c_2 S_2 + c_3 S_3 + \dots}{S_1 + S_2 + S_3 + \dots}$$

where  $c_1, c_2, c_3$ , etc., are the mean chords of various wings, and  $S_1, S_2, S_3$ , etc., are their areas.

**chord, mean of a wing**—The quotient obtained by dividing the wing area by the extreme dimension of the wing projection at right angles to the chord.

**chord wire**—See WIRE (AIRSHIP), CHORD.

**climb, rate of**—See RATE OF CLIMB.

**climbing shaft**—See SHAFT, CLIMBING.

**cloth**—Fabric delivered by the bleachery or finisher before it has been proofed, doped, or specially treated for aeronautic use.

**cloth, ground**—Canvas placed beneath an aerostat for its protection during inflation and deflation.

**cockpit**—The open spaces in which the pilot and passengers are accommodated. (Fig. 1.)

When the cockpit is completely housed in it is called a cabin. (Figs. 1, 6, 9, 10, and 14.)

**compartment, control**—A compartment in the control car of an airship from which all controls are operated. It may be compared to the pilot house of a ship.

**compass, induction**—A compass, the indications of which depend on the current generated in a coil revolving in the earth's magnetic field.

**concentration ring**—See RING, CONCENTRATION.

**condenser, water-recovery**—That part of the water-recovery apparatus which is devoted to the condensing of water in the exhaust gases. It may consist of a number of metal tubes or of a fabric box with appropriate inlets, outlets, and baffles.

**cone, axial**—The cone-shaped fabric, fitting in the end of a gas cell of a rigid airship, which provides a gas-tight connection of the cell to the axial cable and yet permits the cell some degree of freedom in its movements. A special form of conical sleeve. (Fig. 4.)

**cone, danger**—A pennant on the wire cable of a captive balloon to warn aircraft of its presence. Usually a hollow cone of light cloth.

**cone, mooring**—The grooved conical member at the extreme bow of an airship which engages with a hollow cone at the top of the mooring mast and provides the coupling between the airship and the mooring mast. (Fig. 4)

**conical sleeve**—See SLEEVE, CONICAL.

**container, gas**—See CELL, GAS, which is to be preferred.

**control car**—See CAR, CONTROL.

**control compartment**—See COMPARTMENT, CONTROL.

**controllability**—The quality in an airplane which makes it possible for the pilot to change its attitude easily and with the exertion of but little force.

**control lines**—See LINES, CONTROL.

**controls**—A general term applied to the means provided to enable the pilot to control the speed, direction of flight, attitude, and power of an aircraft.

**air controls**—The means employed to operate the control surfaces of the aircraft.

**engine controls**—The means employed to control the power output of the engines. (Control of speed may be effected by the air controls or the engine controls independently, or by either in conjunction with the other.)

**control stick**—The vertical lever by means of which the longitudinal and lateral controls of an airplane are operated. Pitching is controlled by a fore-and-aft movement of the stick, rolling by a side-to-side movement. (Fig. 1.)

**control surface**—See SURFACE, CONTROL.

**cord grommet**—See GROMMET.

**cord netting**—See NET, GAS CELL (RIGID AIRSHIP).

**cord, rip.**—The rope running from the rip panel to the car or basket, the pulling of which tears off or rips the rip panel and causes immediate deflation. (Figs. 2 and 3.)

**cover, outer**—The outside covering of the hull of a rigid airship, usually of some kind of fabric. Sometimes called the "envelope." (Figs. 4 and 5.)

**cover, valve**—See HOOD, VALVE.

**cowling**—A removable covering which extends over or around the engine, and sometimes over a portion of the fuselage or nacelle as well. (Figs. 1, 6, 10, and 14.)

**cradle:**

**building**—A support provided for the frame of a rigid airship or the keel of a semirigid airship during construction.

**docking**—A support for the car of an airship while it is being inflated in the shed. Mostly used with rigid airships.

**crew, ground**—See CREW, LANDING.

**crew, landing**—A detail of men necessary for the landing and handling of an airship on the ground. A "ground crew."

**critical angle**—See ANGLE, CRITICAL.

**critical speed**—See SPEED, CRITICAL.

**cross-country flight**—See FLIGHT, CROSS-COUNTRY.

**cross-wind force**—See FORCE, CROSS-WIND.

**crow's-foot**—A system of diverging short ropes for distributing the pull of a single rope.

An arrangement in which the strands of a cord are opened out so that they can be effectively cemented to a fabric surface.

**cruciform girder**—See GIRDER, CRUCIFORM.

**damping factor**—The factor  $e^{-\lambda t}$  in the equation of damped harmonic motion.

$$s = Ae^{-\lambda t} \sin pt.$$

**danger cone**—See CONE, DANGER.

**dead load**—See WEIGHT, EMPTY, which is to be preferred.

**decalage**—The acute angle between the wing chords of a biplane or multiplane. (Fig. 1.)

**deflation**—The act of removing gas and air from an aerostat.

**deflation sleeve**—See SLEEVE, DEFLATION.

**diametral wire**—See WIRE (AIRSHIP), DIAMETRAL.

**diaphragm, ballonet**—The fabric partition between the gas and air compartments of the envelope of a nonrigid or semirigid airship or kite balloon.

**dihedral angle.**—See ANGLE, WING-DIHEDRAL.

**dirigible**—That can be directed; steerable; as a dirigible balloon. Its use as a noun to indicate an airship is improper.

**dischargeable weight**—See WEIGHT, DISCHARGEABLE.

**displacement**—The mass of air displaced by the gas used for inflation. It may be expressed as a weight or volume. In the latter case it is usually called "volume."

**displacement, aerodynamic volume or air volume**—The weight of a mass of air equal to the aerodynamic volume of the airship in N. A. C. A. standard atmosphere at sea level.

**disposable weight**—See WEIGHT, DISPOSABLE (AIRSHIP).

**dive**—A steep descent, with or without power, in which the air speed is greater than the maximum speed in horizontal flight.

**divergence**—A motion in which, after a disturbance from equilibrium, the body departs continuously, without oscillations, from its original state of motion.

**dock**—A term sometimes applied to an airship shed.

**docking cradle**—See CRADLE, DOCKING.

docking rail—See RAIL, DOCKING.

docking trolley—See TROLLEY, DOCKING.

dope (airplane)—The liquid material applied to the cloth surfaces of airplanes to increase strength, to produce tautness by shrinking, and to act as a filler for maintaining air-tightness.

dope (airship)—The liquid material applied to rubberized airship fabric to increase gas tightness. In contrast with airplane dope, it does not cause shrinking.

dope (pigmented)—An aircraft dope to which a pigment has been added to make an opaque finish, or to protect it from the effects of sunlight.

downwash angle—See ANGLE, DOWNWASH.

drag—The component parallel to the relative wind of the total air force on an aircraft or airfoil. Its symbol is  $D$ .

The "absolute drag coefficient" is  $C_D$  as defined by the equation  $C_D = \frac{D}{qS}$ , in which  $D$  is the drag,  $q$  is the impact pressure ( $= \frac{1}{2} \rho V^2$ ) and  $S$  is the effective area of the surface upon which the air force acts.

In the case of an airplane, that part of the drag due to the wings is called "wing drag"; that due to the rest of the airplane is called "structural drag" or "parasite resistance."

induced—That portion of the wing drag induced by, or resulting from, the generation of the lift.

profile—That portion of the wing drag which is due to friction and turbulence in the fluid and which would be absent in a nonviscous fluid.

drag, mooring—A movable and/or variable weight, suspended from the after part of an airship's structure while moored at a mast, to aid in restraining the vertical and lateral motions of the stern of the airship.

drag rope—See ROPE, DRAG.

drag strut—See STRUT, DRAG.

drift—The lateral velocity of an aircraft due to air currents.

drift angle—See ANGLE, DRIFT.

drift bar—A part of a drift meter or other instrument for indicating the apparent direction of motion of the ground relative to the fore-and-aft axis of the aircraft. It usually consists of a wire or arm which can be set along this direction of motion. Cf. drift.

drift meter—An instrument for measuring the angle between the fore-and-aft axis of an aircraft and its path over the ground. One form consists of a drift bar provided with a suitable angular scale. (Cf. drift.) The instrument is graduated to read correctly when it is level.

drip band—See FLAP, DRIP.

drip flap—See FLAP, DRIP.

drip strip—See FLAP, DRIP.

D—ring—A ring having (as the name implies) the shape of a capital D, to which rope suspensions are attached.

drogue—See ANCHOR, SEA.

dry weight of an engine—See ENGINE, DRY WEIGHT OF.

duralumin—An alloy of aluminum which is much used in aeronautics, especially for the structure of airships and airplanes. Its chemical composition and physical properties are about as follows:

Copper, 3.5 to 4.5 per cent.

Manganese, 0.4 to 1 per cent.

Magnesium, 0.2 to 0.75 per cent.

Aluminum, 92 per cent, minimum.

Tensile strength, ultimate, 55,000 pounds per square inch.

Tensile strength at elastic limit, 30,000 pounds per square inch.

Elongation of 2 inches at ultimate strength (test specimen  $\frac{1}{2}$  inch wide), 18 per cent.

Specific gravity not more than 2.85.

- dynamic factor**—The ratio between the load carried by any part of an aircraft when accelerating and the corresponding basic load.
- dynamic lift**—See LIFT, DYNAMIC.
- dynamic load**—See LOAD, DYNAMIC.
- dynamic (or impact) pressure**—The product  $\frac{1}{2} \rho V^2$ , where  $\rho$  is the density of the air and  $V$  is the relative speed of the air. It is the quantity measured by most air-speed instruments. symbol is  $q$ .
- dynamic trim**—See TRIM, DYNAMIC.
- economic speed**—See SPEED, ECONOMIC.
- effective helix angle**—See ANGLE, EFFECTIVE HELIX.
- effective thrust**—See THRUST, EFFECTIVE.
- elevator**—A movable auxiliary airfoil, the function of which is to impress a pitching moment on the aircraft. The elevator is usually hinged to the stabilizer. (Figs. 1, 3, 4, 5, 6, 9, 10, 13, and 14.)
- elevator angle**—See ANGLE, ELEVATOR.
- endurance**—The maximum length of time an aircraft can remain in the air at a given speed and altitude.
- engine altimeter**—See ALTIMETER, ENGINE.
- engine, barrel-type**—An engine having its cylinders arranged equidistant from and parallel to the main shaft.
- engine controls**—See CONTROLS.
- engine, dry weight of an**—The weight of the engine, including carburetor and ignition systems complete, propeller hub assembly, reduction gears, if any, but excluding exhaust manifolds, oil, and water. If the starter is built into the engine as an integral part of the structure its weight shall be included.
- engine, inverted**—An engine having its cylinders below the crankshaft.
- engine, left-hand**—An engine whose propeller shaft, to an observer facing the propeller from the antipropeller end of the shaft, rotates in a counterclockwise direction.
- engine, radial**—An engine having stationary cylinders arranged radially around a common crankshaft.
- engine, right-hand**—An engine whose propeller shaft, to an observer facing the propeller from the antipropeller end of the shaft, rotates in a clockwise direction.
- engine, rotary**—An engine having revolving cylinders arranged radially around a common fixed crankshaft.
- engine, supercharged**—An engine with mechanical means for increasing the cylinder charge beyond that normally taken in at the existing atmospheric pressure and temperature.
- engine, vertical**—An engine having its cylinders arranged vertically above the crankshaft.
- engine, V-type**—An engine having its cylinders arranged in two rows, forming, in the end view, the letter "V."
- engine, W-type**—An engine having its cylinders arranged in three rows, forming, in the end view, the letter "W." Sometimes called the "broad-arrow type."
- entering edge**—See LEADING EDGE.
- envelope**—The outer covering of an aerostat, usually of fabric. It may or may not be also the gas container. It may be divided by diaphragms into separate gas compartments or cells, and it may also contain internal air cells or ballonets. (Figs. 2, 3, 4, 5, 11, 12.)
- equipment, ground**—See GEAR, GROUND.
- fabric, balloon**—The finished material, usually rubberized, of which balloon or airship envelopes are made.
- biased**—Plied fabric in which the threads of the plies are at an angle to each other.
- parallel**—Plied fabric in which the threads of the plies are parallel to each other.
- fabric, gas-cell**—The fabric used in gas cells of rigid airships, usually goldbeater's skin fabric, q. v.

- fabric, goldbeater's skin**—A gas containing fabric consisting of a layer of light, fine, strong cloth, usually cotton, to which one or more layers of goldbeater's skins have been cemented. The skins are on the inside and are usually further protected by a coat of fine varnish. Usually used in the gas cells of rigid airships.
- factor, dynamic**—See DYNAMIC FACTOR.
- factor of safety**—The ratio of the ultimate strength of a member to the maximum probable load in that member in actual use.
- fairing**—An auxiliary member or structure whose primary function is to reduce head resistance or drag of the part to which it is fitted (without, in general, contributing strength).
- fairing wire**—See WIRE, FAIRING.
- field-handling frame**—See FRAME, FIELD-HANDLING.
- filling sleeve**—See SLEEVE, FILLING.
- fin**—A fixed surface, attached to a part of the aircraft, parallel to the longitudinal axis, in order to secure stability; for example, tail fin, skid fin, etc. Fins are sometimes adjustable. (Figs. 1, 3, 4, 5, 6, 9, 10, 13, and 14.)
- fin carrier**—See CARRIER, FIN.
- fin girder**—See GIRDER, FIN.
- finger patch**—See PATCH, FINGER.
- fire wall**—A fire-resistance transverse bulkhead, so set as to isolate the engine compartment from the other parts of the structure and thus to reduce the risk from fire in the engine compartment. (Fig. 1.)
- fitting**—A generic term for any small part used in the structure of an airplane or airship. If without qualification, a metal part is usually understood. It may refer to other parts, such as "fabric fittings."
- fixed fuel tank**—See TANK, FIXED FUEL.
- fixed power-plant weight for a given airplane**—See WEIGHT, FIXED, POWER-PLANT, FOR A GIVEN AIRPLANE.
- fixed surface**—See FIN.
- fixed weight**—See WEIGHT, FIXED (AIRSHIP).
- flap, drip**—A strip of fabric attached by one edge to the envelope of an aerostat so that rain runs off its free edge instead of dripping into the basket or car. It also assists in keeping the suspension ropes dry and nonconducting. Also called "drip band" and "drip strip."
- flap, pressure**—A flap valve fitted in the outer cover or envelope of a rigid airship and arranged to permit the rapid flow of air in and out—particularly inward. The purpose is to facilitate the rapid equalization of the pressure of the air within the envelope with that of the surrounding air.
- flight, cross-country**—A flight which necessitates leaving the vicinity of a regular landing field.
- flight indicator**—See INDICATOR, FLIGHT.
- flight path**—The path of the center of gravity of an aircraft with reference to the earth.
- flight recorder**—See RECORDER, FLIGHT.
- float**—A completely inclosed water-tight structure attached to an aircraft in order to give it buoyancy and stability when in contact with the surface of the water. In float seaplanes the crew is carried in a fuselage or nacelle separate from the float. (Fig. 10.) The term "pontoon" is now obsolete.
- flotation gear**—See GEAR, FLOTATION.
- flying boat**—A form of seaplane supported, when resting on the surface of the water, by a hull or hulls providing flotation in addition to serving as fuselages. (Fig. 9.) For the central hull type, lateral stability is usually provided by wing-tip floats. The term "boat seaplane" is now obsolete.

**force, cross-wind**—The component, perpendicular to the lift and to the drag, of the total air force on the aircraft or any part thereof. Its symbol is  $C$  and its absolute coefficient  $C_c$  is defined by

$$C_c = \frac{C}{qS}$$

where  $q$  is the impact pressure ( $= \frac{1}{2} \rho V^2$ ) and  $S$  is the effective area of the surface upon which the air force acts.

**frame, field-handling**—A portable frame which may be attached to an airship when it is on the ground and which is intended to afford a grasp to more men than could get on the handling rails of the cars. These frames are rarely carried when in flight. (Fig. 4.)

**framing, stern**—All framework, aft of the cruciform girder, necessary to complete the shape and contour of a rigid airship.

**free balloon**—See BALLOON, FREE.

**free-balloon net**—See NET, FREE-BALLOON.

**fuel (or oil) consumption, specific**—The weight of fuel (or oil) consumed per brake horsepower-hour.

**fuel tank, fixed**—See TANK, FIXED FUEL.

**full load**—See LOAD, FULL.

**fuselage**—The structure, of approximately streamline form, to which are attached the wings and tail unit of an airplane. In general it contains the power plant, passengers, cargo, etc. (Figs. 1, 6, and 10.)

**fuselage, monocoque**—A type of fuselage construction wherein the structure consists of a thin shell of wood, metal, or other material, supported by ribs, frames, belt frames, or bulkheads, but usually without longitudinal members other than the shell itself. The whole is so disposed as to carry the stresses to which the structure is subjected. (Fig. 6.)

**gap**—The distance between the planes of the chords of any two adjacent wings, measured along a line perpendicular to the chord of the upper wing at any designated point of its leading edge. (Fig. 1.) Its symbol is  $G$ .

**gas bag**—See HULL (AIRSHIP) and CELL, GAS.

**gas capacity, nominal**—See CAPACITY, NOMINAL GAS.

**gas cell**—See CELL, GAS.

**gas-cell alarm**—See ALARM, GAS-CELL.

**gas-cell fabric**—See FABRIC, GAS-CELL.

**gas-cell, net**—See NET, GAS-CELL (RIGID AIRSHIP).

**gas container**—See CELL, GAS.

**gas shaft**—See SHAFT, GAS.

**gas-shaft hood**—See HOOD, GAS-SHAFT.

**gassing**—The operation of replenishing a balloon with fresh gas to increase the purity or to make up for loss of gas.

**gassing factor**—The quantity of aerostatic gas required to maintain an aerostat for one year. It is ordinarily expressed as a percentage of the gas volume.

**gas volume**—See VOLUME, GAS (AIRSHIP).

**gear, flotation**—An emergency gear attached to a landplane to permit alighting on the water and to provide buoyancy when resting on the surface of the water.

**gear, ground**—The gear, or equipment, necessary for the landing and handling of an airship on the ground.

**girder, box**—Any girder of rectangular section. Frequently used to refer to the rectangular, longitudinal members in the keel of a rigid airship from which fuel tanks and gas bags are suspended.

**girder, cruciform**—The structure, consisting of vertical and horizontal transverse girders, which is fitted at the stern of a rigid airship for the purpose of supporting the inboard ends of the stern posts of the fins or the rudder posts. It may be integral with the stern posts which form the after ends of the fins.

**girder, fin**—A girder of a rigid airship which goes to make up the fin.

- girder, propeller reinforcing**—A light additional member fitted in the structure of a rigid airship to reinforce those areas of the outer cover which are affected by the propeller wash.
- girder, walkway**—The girder forming the support of a walkway through the keel or in other localities in a rigid or semirigid airship. (Fig. 4.)
- gland**—a short tube fitted to an envelope or gas bag in such a manner that a rope or line may slide through without leakage of gas or air. (Figs. 2 and 5.)
- gland, manometer-tube**—A gland fitted to the envelope of an aerostat to form a gas-tight connection for the tube leading to the manometer in the car. Same as "pressure-tube gland."
- gland, pressure-tube**—See GLAND, MANOMETER-TUBE.
- glide**—A descent with reference to the air at a normal angle of attack and without engine power sufficient for level flight in still air, the propeller thrust being replaced by a component of gravity along the line of flight. Also used as a verb.
- glider**—A form of aircraft similar to an airplane, but without a power plant.
- goldbeater's-skin fabric**—See FABRIC, GOLDBEATER'S-SKIN.
- gondola**—The car of an airship. This use of the word is borrowed from the Italian via the German. "Car" is to be preferred.
- gore**—The portion of the envelope of a balloon or airship included between two adjacent meridian seams.
- grab line**—See LINE, HANDLING.
- grommet**—A small ring of cord.
- gross lift (airship)**—See LIFT, GROSS (AIRSHIP).
- ground angle**—See ANGLE, LANDING.
- ground cloth**—See CLOTH, GROUND.
- ground crew**—See CREW, LANDING.
- ground equipment**—See GEAR, GROUND.
- ground gear**—See GEAR, GROUND.
- ground speed**—See SPEED, GROUND.
- ground-speed meter**—An instrument for measuring the speed of an aircraft relative to the ground. In present types of instruments some reference line in the instrument must first be set parallel to the apparent direction of motion of the aircraft with reference to the ground before the speed measurement is made. This is usually accomplished by the use of a drift meter, the adjustment of which automatically orients the ground-speed meter properly. Thus both the magnitude and direction of the motion of the aircraft with reference to the ground are obtained.
- guy, yaw**—See LINE, YAW.
- gyroscopic turn indicator**—See INDICATOR, GYROSCOPIC TURN.
- handling line**—See LINE, HANDLING.
- hangar**—A shelter for housing aircraft. More properly applied to heavier-than-air craft.
- harness, mooring**—A system of webbing bands, fitted over the top of the envelope of a balloon, to which are attached the mooring ropes. Usually found only in kite balloons or observation balloons. (Fig. 2.)
- height, pressure**—The altitude at which the gas cells of a rigid airship are full, or the gas bag of a nonrigid airship is completely full of gas.
- helicopter**—A form of aircraft whose sole support in the air is derived directly from the vertical component of the thrust produced by rotating airfoils.
- hog**—A distortion of an airship in which the longitudinal axis becomes convex upward so that both ends droop.
- hood, gas-shaft**—A hood, or cowl, located on the outer cover of a rigid airship at the outer end of a gas shaft. It is usually made of light wood and fabric and is faced to facilitate the escape of gas. Sometimes called "exhaust-gas hood."
- In view of the possibility of confusion with the parts of an engine exhaust system, it is believed that "gas-shaft hood" is to be preferred. (Fig. 4.)

- hood, maneuvering-valve**—A hood, or cowl, located on the outer cover of a rigid airship just over a maneuvering valve. It is usually made of light wood or fabric and is faced to facilitate the escape of gas. (Fig. 4.)
- hood, valve**—The appliance, having the form of a hood or parasol which protects the valve of an airship or balloon against rain. Also called "valve cover" or "bonnet." (Figs. 2, 4, and 5.)
- horn**—A short lever attached to a control surface of an aircraft. For example, aileron horn, rudder horn, elevator horn. (Figs. 1, 3, 9, 10, 13, and 14.)
- horsepower of an engine, maximum**—The maximum horsepower which an engine can develop.
- horsepower of an engine, rated**—The average horsepower developed by an engine of a given type in passing the standard 50-hour endurance test.
- hull (airship)**—The main structure of a rigid airship, consisting of a covered elongated framework which incloses the gas cells and supports the cars and equipment. (Fig. 4.) May also be applied to the complete buoyant unit of any aerostat. In this latter sense sometimes called "gas bag."
- hull (seaplane)**—The portion of a flying boat which furnishes buoyancy when in contact with the surface of the water. It contains accommodations for the crew and passengers, usually incorporating the functions of a float and fuselage in one unit. (Fig. 9.)
- impact pressure**—See DYNAMIC (OR IMPACT) PRESSURE.
- inclinometer**—An instrument for indicating the attitude of an aircraft. Inclinometers are termed fore-and-aft, lateral, or universal, according as they indicate inclination on the vertical plane through the fore-and-aft axis, or in the vertical plane through the lateral axis, or in both planes, respectively.
- inclinometer, absolute**—An instrument which indicates the attitude of an aircraft with reference to the vertical. The indications of instruments of this type usually depend on gyroscopic action.
- inclinometer, relative**—An instrument which indicates the attitude of an aircraft with reference to apparent gravity, i. e., to the resultant of the acceleration of the aircraft and that due to gravity.
- indicator, air-speed**—See AIR-SPEED METER.
- indicator, ballonet-fullness**—An instrument for indicating the volume of air in a ballonet.
- indicator, flight**—An instrument in which a lateral inclinometer, a fore-and-aft inclinometer, and a turn indicator are combined to form a compact unit.
- indicator, gyroscopic turn**—A turn indicator dependent on gyroscopic action.
- indicator, pitch**—An instrument for indicating the existence of a pitching velocity of an aircraft. Cf. turn indicator.
- indicator, static turn**—A turn indicator actuated by the difference in pressure between static tubes mounted near the wing tips equidistant from the plane of symmetry and in a plane parallel to the lateral axis.
- indicator, turn**—An instrument for indicating the existence of an angular velocity of turn of an aircraft about the normal axis. In horizontal flight it indicates the presence of a yawing velocity. "Turn meter" is the term applied to certain types.
- indraft (inflow)**—The flow of air from in front of the propeller into the blades.
- induced drag**—See DRAG, INDUCED.
- induction compass**—See COMPASS, INDUCTION.
- inflation**—The act of filling a balloon or airship with gas.
- inflation manifold**—See MANIFOLD, INFLATION.
- inflation net**—See NET, INFLATION.
- inflation sleeve**—See SLEEVE, INFLATION.
- inflation tube**—See TUBE, INFLATION.
- inflow**—See INDRAFT.
- inspection window**—See WINDOW, INSPECTION.
- intermediate longitudinal**—See LONGITUDINAL, INTERMEDIATE.

intermediate transverse—See TRANSVERSE, INTERMEDIATE.

inverted engine—See ENGINE, INVERTED.

jackstay—A longitudinal rigging provided to maintain the correct distance between various parts on fittings on an aerostat.

keel (airship)—The assembly of members at the bottom of the hull of a semirigid or rigid airship which provides special strength to resist hogging and sagging and also serves to distribute the effect of concentrated loads along the hull. It may be a simple Gall's chain, as in some semirigids, or a very extensive structure inclosing the corridor, as in most rigids. (Figs. 4 and 5.)

king-post—The main compression member of a trussing system applied to support a single member subject to bending. (Figs. 4 and 6.)

kite—An aircraft heavier than air, restrained by a tow-line and sustained by the relative wind.

kite balloon—See BALLOON, KITE.

kymograph—An instrument for recording the angular oscillations of an aircraft in flight with respect to axes fixed in space. The reference direction is usually given by a gyroscope or a beam of sunlight.

laminated wood—See WOOD, LAMINATED.

landing angle—See ANGLE, LANDING.

landing crew—See CREW, LANDING.

landing field—A field of such a size and nature as to permit of aircraft landing and taking off in safety. It may or may not be part of an airport.

landing field, emergency—A locality, either of water or land, which is adapted for the landing and taking off of aircraft, but which is not equipped with facilities for shelter, supply, and repair of aircraft and is not used regularly for the receipt or discharge of passengers or cargo by air.

landing gear—The understructure which supports the weight of an aircraft when in contact with the surface of the land or water and reduces the shock on landing. There are five common types—boat type, float type, skid type, wheel type, and ski type. (Figs. 1, 6, 9, 10, and 14.) (Amphibian may be a combination of the float or boat type with wheels or skis.)

landing speed—See SPEED, LANDING.

landing T—A large symbol shaped like a capital T which is laid out on a landing field or on the top of a building to guide operators of aircraft in landing and taking off.

landing wire—See WIRE, LANDING.

landplane—An airplane designed to rise from and alight on the land. (Figs. 1, 6, and 14.)

leading edge—The foremost edge of an airfoil or propeller blade. Also called "entering edge."

leak detector—An instrument which detects the presence of hydrogen and other light gases in the air, and which can be adapted to find leaks in a container inflated with such a gas.

left-hand engine—See ENGINE, LEFT-HAND.

left side (engine)—That side which, to an observer looking from the antipropeller end toward the propeller end, lies on the left-hand side.

lift—That component of the total air force on an aircraft or airfoil which is perpendicular to the relative wind and in the plane of symmetry. It must be specified whether this applies to a complete aircraft or to parts thereof. In the case of an airship, this is often called "dynamic lift." Its symbol is  $L$ .

The "absolute lift coefficient" is  $C_L$  as defined by the equation

$$C_L = \frac{L}{qS}$$

in which  $L$  is the lift,  $q$  is the impact pressure ( $= \frac{1}{2} \rho V^2$ ) and  $S$  is the effective area of the surface upon which the air force acts.

lift (of a gas)—The difference of density of air and the gas. Both supposed to be under the same conditions of pressure, temperature, etc.

- lift, dynamic**—The lift impressed on an aerostat by aerodynamic forces.
- lift, gross (airship)**—The lift obtained from a volume of buoyant gas equal to the nominal gas capacity of the aircraft. Obtained by multiplying the nominal gas capacity by the lift per unit volume of the gas used for inflation.
- lift, static (aerostat)**—The resultant upward force on an aerostat at rest obtained by multiplying the actual volume of the air displaced by the density of the air and subtracting the weight of the contained gas. (The volume of the air displaced, multiplied by the difference of density of the air and the contained gas.)
- lift, useful (airship)**—The lift available for carrying fuel, and oil, passengers, cargo, food, and drinking water, guns, ammunition, and bombs. Usually determined by deducting from the gross lift all fixed weights; certain allowances of ballast, fuel, and oil; water; spares and tools; crew and equipment. No standard has as yet been established.
- lift wire**—See WIRE, LIFT.
- line, bow-steadying**—See LINE, YAW.
- line, grab**—See LINE, HANDLING, and ROPE, DRAG.
- line, handling**—A line attached along the side of an airship for use in maneuvering near and on the ground. (Figs. 2, 3, 4, and 5.) Sometimes called "grab line."
- line, main hauling**—Same as MAIN MOORING LINE.
- line, main mooring**—The line dropped from the bow of an airship to be coupled to the mast main mooring line. (Fig. 4.)
- line, mast bow-steadying**—See LINE, MAST YAW.
- line, mast main hauling**—Same as MAST MAIN MOORING LINE.
- line, mast main mooring**—A line led from the main winch of a mooring mast through the mooring attachment at the top of the mast and carried out to a point on the ground well to leeward of the mast. The airship's main mooring line is attached to this line and the airship is hauled to the mast by means of the joined lines. Sometimes called "ground wire"—British.
- line, mast yaw**—One of the lines led from a winch at the base of the mooring mast through snatch blocks and carried out to leeward of the mast. The airship's yaw lines are attached to these lines. The snatch blocks are fixed to anchorages selected so that the joined lines tend to keep the airship into the wind and prevent her overriding the mast. These lines are also sometimes called "mast yaw guys" or "mast bow-steadying lines."
- line, mooring**—A line attached near the bow of an airship for securing it to the ground or to a mooring mast. (Figs. 3, 4, and 5.)
- line, nose-steadying**—See LINE, YAW, which is to be preferred.
- line, sandbag**—A rope extending along the line of suspension ropes or bridles of a kite balloon to which are hooked the sandbags used in mooring the balloon. The purpose is to prevent wear on the suspension cordage.
- lines, control**—The lines of wire and/or stranded cable leading from the control car or compartment to the various parts of an airship and operating (either through mechanisms or directly) the rudders, valves, etc., which control the speed, altitude, etc., of the airship.
- line, suspension**—A line either of cordage or metal, which supports the weight attached to the envelope of a balloon or airship. (Figs. 2, 3, 5, and 11.)
- line, yaw**—A line dropped from the bow of an airship, when mooring to the mast, to act as a steadying line to prevent yawing and overriding the mast. Also called "bow-steadying line" or "yaw guy." ("Side guy wire"—British.)
- load:**
- dead**—See WEIGHT, EMPTY.
- full**—Weight empty plus useful load. Also called "gross weight."
- pay**—That part of the useful load from which revenue is derived, viz., passengers and freight.
- useful**—The crew and passengers, oil, and fuel, ballast other than emergency, ordnance, and portable equipment.

- load, basic**—The load on an aircraft when it is at rest or in a condition of unaccelerated rectilinear flight. (For purposes of stress analysis.)
- load, dynamic**—Any load due to accelerations of an aircraft, and therefore proportional to its mass.
- load factor**—The ratio of any specified load on a member to the corresponding basic load. Generally applied to the ratio of the breaking load to a basic load.
- load ring**—See RING, CONCENTRATION.
- loading, power**—The gross weight of an airplane, fully loaded, divided by the normal brake horsepower of the engine computed for air of standard density unless otherwise stated.
- loading, wing**—The gross weight of an airplane, fully loaded, divided by the area of the supporting surface. The area used in computing the wing loading should include ailerons, but not the stabilizer and elevators.
- lobe**—An air or gas inflated bag fitted at the stern of a kite balloon and acting as a fin or stabilizer to give it aerodynamic stability. (Fig. 2.)
- logarithmic decrement**—The natural logarithm of the ratio of two successive amplitudes in a damped harmonic motion. It is equal to the product  $\lambda T$ , where  $\lambda$  is the coefficient appearing in the damping factor of damped harmonic motion and  $T$  is the period of the motion.
- longeron**—A fore-and-aft member of the framing of an airplane fuselage or nacelle, usually continuous across a number of points of support. (Fig. 1.)
- longitudinal dihedral angle**—See ANGLE, LONGITUDINAL DIHEDRAL.
- longitudinal, intermediate**—An intermediate longitudinal strength member of a rigid airship, which lies between two adjacent main longitudinals and is generally of lighter weight and/or smaller dimension than the main longitudinals. (Fig. 4.)
- longitudinal, main**—A main longitudinal strength member, of a rigid airship, which connects the various transverse frames. (Fig. 4.)
- loop, mooring**—See LOOP, SANDBAG.
- loop, safety**—A loop formed in a rip cord and attached to a securing patch by a breakable cord or a spring clip. It may be formed either inside the envelope and close to the rip panel or outside the envelope near the gland by which the rip cord passes through the envelope. Before the rip panel can be "pulled" the breakable cord must be broken or the clip opened. Accidental "pulling" is thus made unlikely, as the weight of the cord is easily carried by the breakable cord or spring clip.
- loop, sandbag**—A system of cordage loops on the envelope of a balloon for suspending sandbags. See also LINE, SANDBAG.
- main hauling line**—See LINE, MAIN MOORING.
- main longitudinal**—See LONGITUDINAL, MAIN.
- main mooring line**—See LINE, MAIN MOORING.
- main mooring line, mast**—See LINE, MAST MAIN MOORING.
- main shear wire**—See WIRE (AIRSHIP), MAIN SHEAR.
- main supporting surface**—See SURFACE, MAIN SUPPORTING.
- main transverse**—See TRANSVERSE, MAIN.
- maneuverability**—That quality in an aircraft which makes it possible for the pilot to change its attitude rapidly.
- maneuvering valve**—See VALVE, MANEUVERING.
- maneuvering-valve hood**—See HOOD, MANEUVERING-VALVE.
- manhole, appendix**—An appendix of large diameter and usually rather short. It is used more for access than for inflation or deflation. (Fig. 2.)
- manifold, inflation**—A metal or fabric connection with numerous inlets which permits the passage of gas at the same time from a number of sources (either cylinders or gas holders) to the main inflation tube.
- manometer pressure**—See PRESSURE, MANOMETER (AEROSTAT).
- manometer-tube gland**—See GLAND, MANOMETER-TUBE.

- mast bow-steadying line**—See LINES, MAST YAW.
- mast main hauling line**—See LINE, MAST MAIN MOORING.
- mast main mooring line**—See LINE, MAST MAIN MOORING.
- mast, mooring**—A mast or tower at the top of which there is mounted a fitting, so that the bow of an airship may be secured. It is usually provided with a ladder or staircase and a platform at the top, so that crew and passengers may enter or leave the airship, and also with piping for the supply of fuel, gas, and water. Sometimes called "mooring tower."
- mast yaw line**—See LINE, MAST YAW.
- meter, air-speed**—See AIR-SPEED METER.
- meter, ground-speed**—See GROUND-SPEED METER.
- meter, superheat**—An instrument for measuring the difference in temperature between the gas in a gas container of a lighter-than-air craft and the surrounding air.
- minimum gliding angle**—See ANGLE, MINIMUM GLIDING.
- minimum speed**—See SPEED, MINIMUM.
- monocoque fuselage**—See FUSELAGE, MONOCOQUE.
- monoplane**—An airplane which has but one main supporting surface, sometimes divided into two parts by the fuselage. (Fig. 6.)
- mooring band**—See BAND, MOORING.
- mooring cone**—See CONE, MOORING.
- mooring-cone outrigger**—See OUTRIGGER, MOORING-CONE.
- mooring drag**—See DRAG, MOORING.
- mooring harness**—See HARNESS, MOORING.
- mooring line**—See LINE, MOORING.
- mooring loop**—See LOOP, SANDBAG.
- mooring mast**—See MAST, MOORING.
- mooring ring**—See RING, MOORING.
- mooring rope**—See ROPE, MOORING.
- mooring, three-point**—A system of mooring an airship. It consists primarily of three lines running from a mooring ring (or point) on the airship to three points on the ground. These points are usually at the vertices of an equilateral triangle. The lines may be secured to anchorages at the points, or run over snatch blocks and to equalizing gear. The endeavor is to moor the airship in such a manner that the dynamic lift, due to the relative wind, shall keep the airship at a constant height from the ground. May be considered as a substitute for a mooring mast, usually an emergency substitute.
- mooring tower**—See MAST, MOORING.
- multiplane**—An airplane with two or more main supporting surfaces placed one above another.
- nacelle**—An inclosed shelter for passengers or for a power plant. A nacelle is usually shorter than a fuselage, and does not carry the tail unit. (Fig. 14.)
- net:**
- free-balloon**—A rigging made of ropes and twine shaped to the upper surface of the envelope, which supports the weight of the basket, etc., and distributes the load over the entire upper surface of the envelope. (Fig. 11.)
- gas-cell (rigid airship)**—A netting of cord of small mesh which is intended to assist the fabric of the gas cells in transmitting gas force to a wire netting of coarser mesh and to the longitudinals, both being fitted between the longitudinals. It may be compared to the net of a free balloon. Sometimes called "gas-cell netting" or "cord netting." (Fig. 4.)
- inflation**—A rectangular net of cordage used to restrain the envelope of a kite balloon or airship during inflation. Also applied to a free-balloon net designed to be removed after inflation.
- netting cord**—See NET, GAS CELL (RIGID AIRSHIP).

- netting wire—See WIRE (AIRSHIP), NETTING.
- nominal gas capacity—See CAPACITY, NOMINAL GAS.
- nonrigid airship—See AIRSHIP, NONRIGID.
- nose (airship)—Sometimes used for bow.
- nose batten—See STIFFENER, BOW.
- nose cap—See CAP, BOW, which is to be preferred.
- nose-heavy—The condition of an airplane in normal flight when the distribution of forces is such that, if the longitudinal controls were released, the nose would drop.
- nose-heavy (airship)—See BOW-HEAVY.
- nose-steadying line—See LINE, YAW.
- nozzle, pressure—An instrument which, in combination with a gauge, is used to measure the indicated speed of an aircraft relative to the air. It may be a Pitot-static or a Venturi tube, or a combination of a Pitot tube and a Venturi tube.
- nurse balloon—See BALLOON, CONSTANT PRESSURE.
- nursing tube—See TUBE, SUPPLY.
- observation balloon—See BALLOON, OBSERVATION.
- observation platform—See PLATFORM, OBSERVATION.
- optical altimeter—See ALTIMETER, OPTICAL.
- ornithopter—A form of aircraft heavier than air, deriving its chief support and propelling force from flapping wings.
- oscillation, phugoid—A long-period oscillation characteristic of the disturbed longitudinal motion of an aircraft. This is referred to when it is said that an aircraft "hunts."
- oscillation, stable—An oscillation whose amplitude does not increase.
- oscillation, unstable—An oscillation whose amplitude increases continuously until an attitude is reached from which there is no tendency to return toward the original attitude, the motion becoming a steady divergence.
- outer cover—See COVER, OUTER.
- outrigger, mooring-cone—The member, usually tubular, which supports the mooring cone at the bow of the airship. Sometimes referred to as "mooring spindle." (Fig. 4.)
- over-all length—The distance from the extreme-front to the extreme rear of an aircraft, including the propeller and the tail unit.
- overhang—Used in two senses. (1) One-half of the difference in span of any two main supporting surfaces of an airplane. The overhang is positive when the upper of the two main supporting surfaces has the larger span. (Fig. 1.) (2) The distance from the outer strut attachment to the tip of the wings.
- overhead suspension—See SUSPENSION, OVERHEAD.
- pancake, to—To level off an airplane at a greater altitude than normal in a landing, thus causing it to stall and to descend on a steeply inclined path with the wings at a very large angle of attack and without appreciable bank.
- panel (aerostat)—The unit piece of fabric of which the envelope or outer cover of an aerostat is made. Panels may be assembled into sections, gores, or rings, according to the method of manufacture followed.
- In rigid airships the area bounded by two adjacent longitudinals and two adjacent transverses is often referred to as a "panel." This is a structural panel and the expression is borrowed from structural engineers.
- panel, rip—A strip of fabric inserted or fitted in the upper part of the envelope of a balloon or semirigid or nonrigid airship which is torn or ripped open when immediate deflation is desired. (Figs. 2 and 3.)
- panel (wing parts)—Where a wing surface comprises several units of construction, these units are designated as panels.
- parasite resistance—See DRAG.

- patch**—A strengthened or reinforced flap or fabric of special shape and construction, which is cemented to the envelope or gas cell. It usually forms an anchor by which some portion of the structure may be attached to the envelope, or by which the positioning lines controlling the gas cell, may be attached to the cell. (Fig. 12.)
- patch, chafing**—A patch of fabric secured to the envelope of an aerostat to protect it from abrasion.
- patch, channel**—A channel-shaped fabric-fitting secured to the envelope of an aerostat to allow a rod or spar to be laced to the envelope.
- patch, finger**—A special form of patch having extensions or "fingers" extending out from the central portion. The "fingers" may be of tape, frayed out rope, or fabric. Their function is to distribute the load more widely to the fabric of the envelope or gas cells. (Fig. 12.)
- patch, suspension**—A patch, secured to the envelope or to a gas cell of an aerostat, to which a suspension line may be attached. (Fig. 12.)
- pay load**—See **LOAD, PAY**.
- pendant, sighting**—A vertical wire on center line and forward of the control car of an airship, used as a mark in steering, to assist in determining wind direction.
- performance testing**—See **TESTING, PERFORMANCE**.
- period**—The time taken for a complete oscillation.
- permeability**—The measure of the rate of diffusion of gas through intact balloon fabric; usually expressed in liters of hydrogen per square meter of fabric per 24 hours, under standard conditions of pressure and temperature.
- phugoid oscillation**—See **OSCILLATION, PHUGOID**.
- pigmented dope**—See **DOPE (PIGMENTED)**.
- pilot**—An operator of aircraft. This term is applied regardless of the sex of the operator.
- pilot balloon**—See **BALLOON, PILOT**.
- pitch, angle of**—See **ANGLE OF PITCH**.
- pitch indicator**—See **INDICATOR, PITCH**.
- pitch of a propeller:**
- effective**—The distance which an aircraft advances along its flight path for one revolution of the propeller. Its symbol is  $p_e$ .
  - geometrical**—The distance which an element of a propeller would advance in one revolution, if it were moving along a helix of slope equal to its blade angle.
  - mean geometrical**—The mean of the geometrical pitches of the several elements. Its symbol is  $p_g$ .
  - standard**—The geometrical pitch taken at two-thirds of the radius. Also called "nominal pitch." Its symbol is  $p_s$ .
  - zero thrust**—The distance which a propeller would have to advance in one revolution in order that there might be no thrust. Also called "experimental mean pitch." Its symbol is  $p_v$ .
  - zero torque**—The distance which a propeller would have to advance in one revolution in order that the torque might be zero. Its symbol is  $p_a$ .
- pitch ratio**—The ratio of the pitch (geometrical, unless otherwise stated) to the diameter  $p/D$ .
- pitch speed**—The product of the mean geometrical pitch by the number of revolutions of the propeller in unit time—i. e., the speed the aircraft would make if there were no slip.
- Pitot tube**—A cylindrical tube with an open end which is pointed upstream (i. e., so that the air meets the instrument head-on or is met head-on by the instrument). When the aircraft is flying less than about 200 miles per hour, the instrument measures the impact pressure. When used on aircraft, it is usually associated either with a closed coaxial tube surrounding it or with a closed tube placed near it and parallel to it, the combination being termed a Pitot-static tube. The associated tube has perforations in its side so that it is subjected to static pressure, as distinct from impact pressure. The speed of the fluid can be determined from the difference between the impact pressure and the static pressure as read by a suitable gauge. (Fig. 7.) In common terminology the Pitot-static combination, as above, is often termed simply a Pitot tube or Pitot.

**platform, observation**—A platform or small deck fitted on the top of an airship and used as a post for a lookout and defense or as a place from which to make observations used in navigating the airship. (Figs. 4 and 5.)

**plywood**—A product formed by gluing together two or more layers of veneer. The alternate plies are usually placed with grain at right angles to the adjacent plies.

**pontoon (now obsolete)**—See FLOAT.

**power loading**—See LOADING, POWER.

**pressure alarm**—See ALARM, GAS-CELL.

**pressure, dynamic**—See DYNAMIC (OR IMPACT) PRESSURE.

**pressure flap**—See FLAP, PRESSURE.

**pressure height**—See HEIGHT, PRESSURE.

**pressure, manometer (aerostat)**—The excess of pressure inside the envelope of an aerostat over the atmospheric pressure at a standard reference point. The point of reference for the excess of pressure is usually the bottom of the envelope or gas cell for airships and the level of the basket for kite balloons.

**pressure nozzle**—See NOZZLE, PRESSURE.

**pressure-relief vent**—See VENT, PRESSURE-RELIEF.

**pressure tube**—See TUBE, PRESSURE.

**pressure-tube gland**—See GLAND, MANOMETER-TUBE.

**profile**—See AIRFOIL SECTION (OR PROFILE).

**profile drag**—See DRAG.

**proofing**—Material incorporated in the fabric of an aerostat at the time of manufacture to increase its resistance to the weather and/or to prevent the passage of gas (or decrease its permeability).

**propaganda balloon**—See BALLOON, PROPAGANDA.

**propeller:**

**adjustable pitch**—A propeller whose blades are so attached to the hub that they may be set to any desired pitch when the propeller is stationary.

**controllable pitch or variable pitch**—A propeller whose blades are so mounted that they may be turned about their axis to any desired pitch while the propeller is in rotation.

**propeller area, projected**—The total area in the plane perpendicular to the propeller shaft swept by the propeller, excepting the portion covered by the boss and that swept by the root of the blade. This portion is usually taken as extending 0.2 of the maximum radius from the axis of the shaft.

**propeller blade**—See BLADE FACE; BLADE BACK; BLADE-WIDTH RATIO. (Fig. 1.)

**propeller-blade angle**—See ANGLE, PROPELLER-BLADE.

**propeller-blade area**—The area of the blade face, exclusive of the boss and the root, i. e., of a portion which is usually taken as extending 0.2 of the maximum radius from the axis of the shaft.

**propeller boss**—The central portion of a propeller in which the hub is formed or mounted. (Fig. 1.)

**propeller-camber ratio**—The ratio of the maximum thickness of a propeller section to its chord.

**propeller-disk area, total**—The total area swept by a propeller, i. e., the area of a circle having a diameter equal to the propeller diameter.

**propeller efficiency**—The ratio of thrust power to power input of a propeller. Its symbol is  $\eta$ .

**propeller hub**—The metal fitting inserted or incorporated in or with a propeller for the purpose of mounting it on the propeller or engine shaft. (Fig. 1.)

**propeller interference**—The amount by which the torque and thrust of a propeller are changed by the modification of the air flow in the slip stream produced by bodies placed near the propeller, such as engine, radiator, etc.

**propeller-load curve**—A curve representing the engine power necessary to drive any given propeller at various speeds. The power required varies approximately as the cube of the speed in R. P. M., provided the ratio  $\frac{V}{ND}$  remains constant.

- propeller pitch**—See PITCH OF A PROPELLER.
- propeller, pusher**—A propeller mounted to the rear of the engine or propeller shaft. (It is usually behind the wing cell or nacelle.) (Figs. 9 and 14.)
- propeller rake**—The mean angle which the line joining the centroids of the sections of a propeller blade makes with a plane perpendicular to the axis.
- propeller reinforcing girder**—See GIRDER, PROPELLER REINFORCING.
- propeller root**—That part of the propeller blade near the boss. (Fig. 1.)
- propeller section**—A cross section of a propeller blade made at any point by a plane parallel to the axis of rotation of the propeller and tangent at the centroid of the section to an arc drawn with the axis of rotation as its center.
- propeller thrust**—The component parallel to the propeller axis of the total air force on the propeller. Its symbol is  $T$ .
- propeller torque**—The moment applied to the propeller by the engine shaft. Its symbol is  $Q$ .
- propeller, tractor**—A propeller mounted on the forward end of the engine or propeller shaft. (It is usually forward of the fuselage or wing nacelle.) (Figs. 1, 6, and 10.)
- propeller-width ratio, total**—The product of blade-width ratio at the point of maximum blade width by number of blades.
- propulsive efficiency**—The ratio of the product of effective thrust and flight speed to the actual power input to the propeller as mounted on the airplane, consistent units being used throughout.
- purity (of gas)**—The ratio of the pressure of the hydrogen (or other aerostatic gas) in the container to the total pressure due to all the contained gases.
- pusher airplane**—See AIRPLANE, PUSHER.
- pusher propeller**—See PROPELLER, PUSHER.
- quadrant**—The operating lever, made on the arc of a circle, of a control surface of an airship, e. g., rudder quadrant, elevator quadrant. (Fig. 4.)
- quadruplane**—An airplane with four main supporting surfaces, placed one above another.
- race rotation**—The rotation, produced by the action of the propeller, of the stream of air passing through or influenced by the propeller.
- radial engine**—See ENGINE, RADIAL.
- radial wire**—See WIRE (AIRSHIP), RADIAL.
- rail, docking**—A rail or guide, constructed on the landing field and extending into the shed, which supplies a means for holding the lateral pull of an airship's docking or handling lines. The pull is transmitted to the rails from wheeled cars or trolleys which are fitted on or in the rails. Usually two rails are fitted at the greatest distance apart which will permit them to be run into the shed.
- rake, propeller**—See PROPELLER RAKE.
- ram**—The combination of tubes and springs which is mounted in gimbals at the top of a mooring mast. It consists of an outer tube which carries the gimbal mounting and within which slides an inner tube. The upper end of the inner tube carries the hollow cone which receives the airship's mooring cone and which is fitted to revolve freely. The inner tube can slide down into the outer tube and compress heavy springs, thus easing the shock when the mooring is made.
- range at economic speed**—The maximum distance a given aircraft can cover while cruising at the most economical speed and altitude at all stages of the flight.
- range at full speed**—The maximum distance a given aircraft can cover at full speed at sea level.
- rate of climb**—The vertical component of the air speed of an aircraft, i. e., its vertical velocity with reference to the air.
- recorder, flight**—An instrument for recording certain elements of the performance of an aircraft.
- relative inclinometer**—See INCLINOMETER, RELATIVE.
- relative wind**—See WIND, RELATIVE.

**resistance derivatives**—Quantities expressing the variation of the forces and moments on aircraft due to disturbance of steady motion. They form the experimental basis of the theory of stability, and from them the periods and damping factors of aircraft can be calculated. In the general case there are 18 translatory and 18 rotary derivatives.

**lateral**—Resistance derivatives expressing the variation of moments and forces due to small changes in the lateral, yawing, and rolling velocities.

**longitudinal**—Resistance derivatives expressing the variation of moments and forces due to small changes in the longitudinal, normal, and pitching velocities.

**rotary**—Resistance derivatives expressing the variation of moments and forces due to small changes in the rotational velocities of the aircraft.

**translatory**—Resistance derivatives expressing the variation of moments and forces due to small changes in the translational velocities of the aircraft.

**restoring moment**—See RIGHTING MOMENT.

**reverse turn**—See TURN, REVERSE.

**revolutions, maximum**—The number of revolutions per minute corresponding to the maximum horsepower.

**revolutions, rated**—The number of revolutions corresponding to the rated horsepower.

**Reynolds Number**—A name given the fraction  $\rho \frac{Vl}{\mu}$  in which

$\rho$  is the density of the fluid;

$V$  is the relative velocity of the fluid;

$l$  is the linear dimension of the body;

$\mu$  is the coefficient of viscosity of the fluid.

**rigger**—One who is employed in assembling and aligning aircraft.

**rigging (aerostat)**—The attachment and adjustment of the car, rudders, valves, controls, etc., of an airship.

**rigging, (airplane)**—The assembling, adjusting, and aligning of the parts of an airplane.

**right-hand engine**—See ENGINE, RIGHT-HAND.

**righting moment (or restoring moment)**—A moment which tends to restore an aircraft to its previous attitude after any small rotational displacement.

**right side (engine)**—That side which, to an observer looking from the antipropeller end toward the propeller end, lies on the right-hand side.

**rigid airship**—See AIRSHIP, RIGID.

**ring, concentration:**

**airship**—A ring to which several rigging lines are led from the envelope and from which one or more lines also lead to the car.

**free balloon**—A ring to which are attached the ropes suspending the basket and to which the net is also secured. Sometimes called "load ring." (Fig. 11.)

**ring, load**—See RING, CONCENTRATION (FREE BALLOON).

**ring, mooring**—A metallic ring suspended from one of the forward frames of a rigid airship by wire lines and used for mooring. The vertex of a "three-point mooring" is attached to this ring.

**rip cord**—See CORD, RIP.

**rip panel**—See PANEL, RIP.

**roll**—A maneuver in which a complete revolution about the longitudinal axis is made, the horizontal direction of flight being approximately maintained.

**roll, angle of**—See ANGLE OF ROLL.

**rope, drag**—A long rope which can be hung overboard from a balloon so as to act as a brake and a variable ballast in making a landing. Same as "trail rope" or "guide rope." On airships a similar rope or ropes is used as a haul-down or mooring line by the landing crew. It is usually larger and longer than a regular handling line. Sometimes called "grab line."

- rope, mooring—A line attached to a balloon or airship for use in securing it to the ground. It may serve the purpose of a "handling line," or vice versa. (Fig. 2.)
- rope, trail—See ROPE, DRAG.
- rotary engine—See ENGINE, ROTARY.
- rudder—A movable auxiliary airfoil, the function of which is to impress a yawing moment on the aircraft in normal flight. It is usually located at the rear of an aircraft. (Figs. 1, 9, 10, and 14.)
- rudder (airship)—A hinged or pivoted surface, usually attached to a fin at the after end of an airship. When operated by the pilot it produces a yawing moment and gives directional control in the plane at right angles to the axis about which it is hinged or pivoted. (Figs. 3, 4, and 5.)
- rudder angle—See ANGLE, RUDDER.
- rudder bar—The foot bar by means of which the control cables leading to the rudder are operated. (Fig. 1.)
- rudder torque—The twisting moment exerted by the rudder on the fuselage. The product of the rudder area by the distance from its center of area to the axis of the fuselage may be used as a relative measure of rudder torque.
- safety, factor of—See FACTOR OF SAFETY.  
load in that member in actual use.
- safety loop—See LOOP, SAFETY.
- sag—A distortion of an airship in which the longitudinal axis becomes concave upward so that both ends rise.
- sandbag line—See LINE, SANDBAG.
- sea anchor—See ANCHOR, SEA.
- seaplane—Any airplane designed to rise from and alight on the water. This general term applies to both boat and float types, though the boat type is usually designated as a "flying boat." (Figs. 9 and 10.)
- secondary shear wire—See WIRE (AIRSHIP), SECONDARY SHEAR.
- semirigid airship—See AIRSHIP, SEMIRIGID.
- service tank—See TANK, SERVICE.
- shaft, climbing—An access shaft fitted with a ladder and leading from the bottom to the top of an airship hull. This may be fitted in an airship of any type. (Figs. 4 and 5.)
- shaft, gas—A duct or shaft leading from the bottom of the gas cells to the outer cover of an airship. It affords a clear passage for the escape of gases which have accumulated in the gangway or corridor or which are discharged from the valves at the bottom of the cells. It usually consists of light wooden hoops or frames spaced at intervals on cords or wires and is covered by a netting. It prevents the gas cells from closing hard against one another and thus keeps the passage open. Sometimes called "gas trunk," "exhaust-gas shaft," or "trunk."
- In view of the possibility of confusion with parts of an engine-exhaust system, it is believed that "gas shaft" or "trunk" is to be preferred. (Fig. 4.)
- sheathing—See TIPPING (PROPELLER).
- shed—A shelter for housing airships.
- ship—Slang for an airplane. In view of the confusion with "airship" it should not be used.
- shipplane—A landplane designed to rise from and alight on the deck of a ship.
- shock absorber—A device incorporated in the landing gear of an aircraft to reduce the shock imposed on the structure when alighting or taking off.
- Shock absorbing devices are usually interposed between the main structure and the wheels, floats, skis, or tail skids, to secure resiliency in landing and taxiing. (Fig. 1.)
- shore—A structural member for supporting the structure of a rigid or semirigid airship during building or docking, used in conjunction with (or without) a cradle.
- side car—See CAR, WING.

**side slipping**—Flight in which the lateral axis is inclined and the airplane has a component of velocity in the direction of the lower end of the lateral axis. When it occurs in connection with a turn, it is the opposite of skidding. (q. v.)

**sighting pendant**—See PENDANT, SIGHTING.

**skid**—A runner used as a member of the landing gear and designed to aid the aircraft in landing or taxiing.

**tail skid**—A skid used to support the tail when in contact with the ground. (Figs. 1, 6 and 14.)

**wing skid**—A skid placed near the wing tip and designed to protect the wing from contact with the ground. (Fig. 1.)

**skidding**—Sliding sidewise away from the center of curvature when turning. It is usually caused by banking insufficiently, and is the opposite of side slipping. (q. v.)

**skid fin**—A fore-and-aft vertical surface, usually placed above the upper wing, designed to provide vertical keel surface and so to increase lateral stability. (Figs. 9 and 10.)

**skin friction**—The tangential component of the fluid force at a point on a surface.

**sky writing**—The act of emitting from an aircraft a trail of smoke or other visible substance, the flight of the aircraft being so directed as to cause the trail to assume the form of letters or symbols.

**sleeve, conical**—A cone-shaped fabric, fitting in a bag or cell through which a line passes. It provides a gas-tight connection of the bag or cell to the line and yet permits both some degree of freedom to move.

**sleeve, deflation**—Generally a sleeve or appendix made of fabric provided for the special purpose of facilitating the deflation of an aerostat. Also applied to the sleeve or appendix fitted in the lower lobe of a kite balloon and used to permit the rapid escape of air in the lobes when the balloon is hauled down. (Fig. 2.)

**sleeve, filling**—See SLEEVE, INFLATION.

**sleeve, inflation (or sleeve, filling)**—A tubular fabric attachment to an envelope or gas bag, serving as a lead for the inflation tube. (Figs. 3 and 5.)

**slip**—The difference between the mean geometrical pitch and the effective pitch. Slip may be expressed as a percentage of the mean geometrical pitch or as a linear dimension.

**slip fuel tank**—See TANK, SLIP FUEL.

**slip function**—The ratio of speed of advance through the undisturbed air to the product of propeller diameter by the number of revolutions in unit time, i. e.,  $\frac{V}{ND}$ . The slip function is the primary factor controlling propeller performance. It is  $\pi$  times the ratio of forward speed to the tip speed of the propeller.

**slip stream**—The stream of air driven astern by the propeller. (The indraft is sometimes included also.)

**snatch-block anchorage**—See ANCHORAGE, SNATCH-BLOCK.

**soar**—To perform sustained free flight without self-propulsion; it is called “up-current soaring” if performed in ascending air; “dynamic soaring” in other cases.

**sounding balloon**—See BALLOON, SOUNDING.

**sound-ranging altimeter**—See ALTIMETER, SOUND-RANGING.

**span (airfoil)**—The lateral dimension of an airfoil, i. e., its dimension perpendicular to its chord. Its symbol is  $b$ .

**span (airplane)**—The maximum distance measured parallel to the lateral axis from tip to tip of an airplane inclusive of ailerons. (Fig. 1.)

**spar**—See WING SPAR.

**specific fuel (or oil) consumption**—See FUEL (OR OIL) CONSUMPTION, SPECIFIC.

**speed, critical**—The lowest speed of an aircraft at which control can be maintained.

**speed, economic**—The speed at which the fuel consumption, per unit of distance covered in still air, is a minimum.

**speed, ground**—The horizontal component of the velocity of an aircraft relative to the earth.

- speed, landing**—The minimum speed at which an airplane can maintain itself in level flight and still be under adequate control.
- speed, minimum**—The lowest steady speed which can be maintained by an airplane in level flight at an altitude large in comparison with the dimensions of the wings, with any throttle setting whatever.
- spin**—A maneuver consisting of a combination of roll and yaw, with the longitudinal axis of the airplane inclined steeply downward. The airplane descends in a helix of large pitch and very small radius, the upper side of the airplane being on the inside of the helix, and the angle of attack on the inner wing being maintained at an extremely large value.
- spindle, mooring**—See **OUTRIGGER, MOORING CONE**.
- spinner**—A fairing of approximately conical or paraboloidal form, which is fitted coaxially with the propeller boss and revolves with the propeller. (Fig. 1.)
- spiral**—A maneuver in which an airplane descends in a helix of small pitch and large radius, the angle of attack being within the normal range of flight angles.
- spiral instability**—See **STABILITY**.
- stability**—That property of a body which causes it, when disturbed from a condition of equilibrium or steady motion, to develop forces or moments which tend to restore the body to its original condition.
- automatic**—Stability dependent upon movable control surfaces automatically operated by mechanical means.
- inherent**—Stability of an aircraft due solely to the disposition and arrangement of its fixed parts, i. e., that property which causes it, when disturbed, to return to its normal attitude of flight without the use of controls or the interposition of any mechanical devices.
- static**—Stability of such a character that, if the airplane is displaced slightly from its normal attitude by rotation about an axis through its center of gravity (as may be done in wind-tunnel experiments), moments come into play which tend to return the airplane toward its original attitude.
- dynamic**—Stability of such a character that, if the airplane is displaced from steady motion in flight, it tends to return to that steady state of motion, the oscillations due to restoring moments being damped out.
- In a general way, the difference between static stability and dynamic stability is that the former depends on restoring moments alone, while the latter includes the action of damping factors.
- longitudinal**—Stability with reference to disturbances in the plane of symmetry, i. e., disturbances involving pitching and variation of the longitudinal and normal velocities.
- directional**—Stability with reference to rotations about the normal axis, i. e., an airplane possesses directional stability in its simplest form if a restoring moment comes into action when it is given a small angle of yaw. Owing to symmetry, directional stability is closely associated with lateral stability.
- lateral**—Stability with reference to disturbances involving rolling, yawing, or side slipping, i. e., disturbances in which the position of the plane of symmetry of the aircraft is affected.
- spiral instability**—A type of instability inherent in certain airplanes which becomes evident when the airplane, as a result of a yaw, assumes too great a bank and side slips; the bank continues to increase and the radius of the turn to decrease.
- stabilizer**—A normally fixed airfoil whose function is to lessen the pitching motion. It is usually located at the rear of an aircraft and is approximately parallel to the plane of the longitudinal and lateral axes. Also called "tail plane."
- stabilizer (aerostat)**—Same as **FIN**. The lobes of a kite balloon are sometimes referred to as stabilizers. (Figs. 1, 2, 3, 4, 5, 6, 9, 10, 13, and 14.)

- stabilizer, mechanical**—A mechanical device to prevent an aircraft from departing from a condition of steady motion, or, in case such a motion is disturbed, to restore it to its steady state. Includes gyroscopic stabilizers, pendulum stabilizers, inertia stabilizers, etc.
- stabilizer setting, angle of**—See ANGLE OF STABILIZER SETTING.
- stable oscillation**—See OSCILLATION, STABLE.
- stagger**—The amount of advance of the leading edge of an upper wing of a biplane, triplane, or multiplane over that of a lower, expressed either as a percentage of gap or in degrees of the angle whose tangent is the percentage just referred to. It is considered positive when the upper wing is forward and is measured from the leading edge of the upper wing along its chord to the point of intersection of this chord with a line drawn perpendicular to the chord of the upper wing at the leading edge of the lower wing, all lines being drawn in a plane parallel to the plane of symmetry. (Fig. 1.)
- stall**—The condition of an airplane when from any cause it has lost the air speed necessary for support or control.
- static ceiling**—See CEILING, STATIC.
- static lift**—See LIFT, STATIC (AEROSTAT).
- static thrust**—See THRUST, STATIC.
- static trim**—See TRIM, STATIC.
- static turn indicator**—See INDICATOR, STATIC TURN.
- station, airship**—The complete assembly of sheds, masts, gas plants, shops, landing fields, and related equipment required to operate airships and supply their needs. A station may include all or a part of the items enumerated. The base from which airships are operated.
- statoscope**—An instrument for detecting minute changes of altitude of an aircraft. The indications of the instrument usually depend on small changes of the static pressure of the air.
- stay**—A wire or other tension member; for example, the stays of the wing and body trussing. (Fig. 1.)
- step**—A break in the form of the bottom of a float or hull designed to reduce resistance when under way by rapidly reducing the wetted surfaces as speed increases. It also serves to eliminate suction effects.
- stern-droop**—A deformation of an airship in which its longitudinal axis bends downward at the after end.
- stern framing**—See FRAMING, STERN.
- stern-heavy**—The condition in which, in normal flight, the after end of an airship tends to sink and which requires correction by means of the horizontal controls. In this condition an airship is said to "trim by the stern." It may be due to either aerodynamic or static conditions, or to both.
- stiffener, bow**—A rigid member attached to the bow of a nonrigid or semirigid envelope to reinforce it against the pressure caused by the motion of the airship. Sometimes called "nose stiffener" or "nose batten." (Figs. 3 and 5.)
- streamline**—The path of a small portion of a fluid relative to a solid body with respect to which the fluid is moving. The term is commonly used only of such flows as are not eddying, but the distinction should be made clear by the context.
- streamline flow**—Steady flow past a solid body, i. e., a flow in which the direction at every point is independent of time.
- streamline form**—A solid body which produces approximately streamline flow.
- stresses, breathing**—Stresses produced in an aerostat by breathing. Of importance in the envelope and keel of a semirigid airship due to the interaction of envelope and keel when the envelope "breathes."
- strip, drip**—See FLAP, DRIP.
- structural drag**—See DRAG.
- strut**—A compression member of a truss frame. For instance, the vertical members of the wing truss of a biplane (interplane struts) and the short vertical and horizontal members separating the longerons (q. v.) in the fuselage. (Fig. 1.)

- strut, drag**—A fore-and-aft compression member of the internal bracing system of a wing. (Figs. 1 and 15.)
- supercharged engine**—See ENGINE, SUPERCHARGED.
- supercharger**—A mechanical device for supplying the engine with a greater weight of charge than would normally be induced at the prevailing atmospheric pressure and temperature.
- centrifugal type**—A supercharging device equipped with one or more rotating impellers generating centrifugal force which is utilized for the compression and the transmission of the air against resistance.
- positive-driven type**—A supercharger driven at a fixed speed ratio from the engine shaft by gears or other positive means.
- rotary-blower type**—A supercharging device comprising one or more relatively slow-speed rotors revolving in a stationary case in such a way as to provide a positive displacement.
- turbo type**—A supercharger driven by a turbine operated by the exhaust gases from the engine.
- superheat**—The amount by which the temperature of the gas in the envelope or gas cells of an aerostat is higher than the temperature of the surrounding air. If the contained gas has a lower temperature, the superheat is said to be negative.
- superheat meter**—See METER, SUPERHEAT.
- supply balloon**—See BALLOON, SUPPLY.
- supply tube**—See TUBE, SUPPLY.
- supporting surface, main**—See SURFACE, MAIN SUPPORTING.
- surface, control**—A movable airfoil designed to be rotated or otherwise moved by the pilot in order to change the attitude of the airplane or airship.
- surface, fixed**—See FIN.
- surface, main supporting**—A set of wings, extending on the same general level from tip to tip of an airplane; e. g., a triplane has three main supporting surfaces. The main supporting surfaces include the ailerons, but no other surfaces intended primarily for control or stabilizing purposes.
- suspension band**—See BAND, SUSPENSION.
- suspension bar**—See BAR, SUSPENSION.
- suspension line**—See LINE, SUSPENSION.
- suspension, overhead**—A line leading from the roof of an airship shed and arranged to sustain the whole or a part of the weight of the structure of an airship when it is docked.
- suspension patch**—See PATCH, SUSPENSION.
- suspension winch**—The rigging by means of which the lift and drag of a kite balloon is transmitted from the envelope to the towing or traction cable. (Fig. 2.)
- sweep back**—The acute angle between the lateral axis of an airplane and the projection of the axis of the wing on the plane which includes the lateral and longitudinal axes. (Fig. 1.) (The axis of a wing is a line through the centroids of the section of the wing.)
- tail (airship)**—Sometimes used for stern.
- tail boom**—A spar or outrigger connecting the tail surfaces and main supporting surfaces. (Fig. 14.)
- tail-droop**—See STERN-DROOP.
- tail group (or tail unit)**—The stabilizing and control surfaces at the rear end of an aircraft, including stabilizer, fin, rudder, and elevator. (Also called "empennage.")
- tail-heavy**—In a heavier-than-air craft, the condition in which in normal flight, the tail sinks if the longitudinal control is released, i. e., the condition in which the pilot has to exert a push on the control stick to keep the given attitude.
- tail-heavy (airship)**—See STERN-HEAVY.
- tail plane**—See STABILIZER.
- tail skid**—See SKID.
- tail slide**—The backward and downward motion, tail first, which certain airplanes may be made to take momentarily after having been brought into a stalling position by a steep climb.

tandem airplane—See AIRPLANE, TANDEM.

tank, fixed fuel—A fuel tank which is not intended or fitted to be dropped, as "slip" tanks are.

tank, service—A fixed fuel tank near each power unit, into which fuel from other tanks is pumped and from which the fuel supplying the engines is drawn.

tank, slip fuel—A fuel tank which is provided with a device permitting the quick dropping of the tank and contents as a whole in case of an emergency. Fitted on both airships and airplanes.

taxi—To run an airplane over the ground, or a seaplane on the surface of water under its own power.

testing, performance—The process of determining performance characteristics.

thermograph—An instrument for recording temperature.

thimble—A grooved ring of circular, pear-, or heart-shaped form, generally of metal, which is inserted in the eye of a rope or wire to prevent chafing or deformation of the eye.

three-point mooring—See MOORING, THREE-POINT.

thrust, effective—The net driving force delivered by a propeller when mounted on an airplane, i. e., the actual thrust given by the propeller, as mounted on the airplane, minus any increase of resistance of the airplane produced by the action of the propeller.

thrust face—See BLADE FACE.

thrust, static—The thrust developed by a propeller when rotating at a fixed point.

tipping (propeller)—A sheet-metal (or equivalent) protective covering of the blade of a propeller near the tip, extended a short distance along the trailing edge and a considerable distance along the leading edge. (Fig. 1.)

toggle—A short crossbar of wood or metal which is fitted at the end of a rope. The rope passes around the mid length of the bar in a shouldered groove. By slipping it through an eye in the end of another rope, the two lengths of rope can be quickly connected or disconnected. (Fig. 2.)

topping up—The operation of filling up with gas an already partially full aerostat. Also applied to a similar operation with fuel tanks. Incorrectly called "nursing."

total propeller-width ratio—See PROPELLER-WIDTH RATIO, TOTAL.

tower, mooring—See MAST, MOORING.

tractor airplane—See AIRPLANE, TRACTOR.

tractor propeller—See PROPELLER, TRACTOR.

trailing edge—The rearmost edge of an airfoil or propeller blade. (Fig. 1.)

trail rope—See ROPE, DRAG.

trajectory band—See BAND, TRAJECTORY.

transverse, intermediate—An open unbraced transverse frame of a rigid airship which lies between two main or braced transverse frames. (Fig. 4.)

transverse, main—A main transverse strengthening frame of a rigid airship provided with wire or girder bracing and spaced at regular intervals throughout the length of the airship. (Fig. 4.)

trapeze bar—See BAR, SUSPENSION.

triangulation balloon—See BALLOON, TRIANGULATION.

trim—The attitude of an aerostat relative to a fore-and-aft horizontal plane. If the forward end is down, the aerostat is said to have "trim by the bow"; if the after end, it has "trim by the stern."

trim, to—To alter the attitude of an aerostat relative to a fore-and-aft horizontal plane. If the endeavor is to force the bow down, the aircraft is "trimmed by the bow"; if the stern, it is "trimmed by the stern." If the aircraft shows a tendency to sink by the bow end, it is said to "trim by the bow" or to be "bow-heavy"; if the tendency is to sink by the stern, it is said to "trim by the stern" or to be "stern-heavy."

trim, dynamic—Trim (or trimming) due to dynamic conditions or their change.

trim, static—Trim (or trimming) due to static conditions or their change.

- triplane**—An airplane with three main supporting surfaces, placed one above another.
- trolley, docking**—A car or trolley fitted on (or in) docking rails to transmit the pull of an airship docking line. It is fitted with wheels having antifriction bearings so it can move freely in the rail. Usually some sort of quick-release device for letting go the line is also fitted.
- tube, inflation**—A fabric tube leading from the inflation manifold or source of supply to the inflation sleeve of the gas cell or envelope.
- tube, nursing**—See TUBE, SUPPLY.
- tube, pressure**—A tube fitted to an envelope or gas bag, to which a pressure gauge may be attached.
- tube, supply**—An elongated appendix or inflation sleeve, fitted on a kite balloon, which is brought down to the basket and fitted with a quick-connection coupling. This coupling can be attached to a similar piece on the deck of the airship and gas may be sent into the balloon shortly after it has reached the deck. A similar tube is sometimes used with airships where constant-pressure nurse balloons are used. This is rare in the United States. (Fig. 2.) Also called "nursing tube."
- turn indicator**—See INDICATOR, TURN.
- turn, reverse**—A rapid maneuver to reverse the direction of flight of an airplane, made by a half loop and half roll.
- unstable oscillation**—See OSCILLATION, UNSTABLE.
- useful lift**—See LIFT, USEFUL (AIRSHIP).
- useful load**—See LOAD, USEFUL.
- valve, automatic**—A spring-loaded relief valve fitted to the envelope, ballonet, or gas cell of an aerostat and set to open at a predetermined pressure for the purpose of preventing excessive internal pressure. (Figs. 4 and 5.)  
Also applied to a type of valve used on some aerostats which opens at a predetermined contained volume or hull dimension.
- valve cover**—See HOOD, VALVE.
- valve hood**—See HOOD, VALVE.
- valve, maneuvering**—A manually operated valve fitted to the envelope, ballonet, or gas cell of an aerostat for the purpose of releasing gas or air from within the envelope or gas cell when desired. (Fig. 4.)
- valve petticoat**—A special sleeve between valve and gas container making it possible to tie off the sleeve and change valves without loss of gas.
- valve seal**—A fabric cover used to seal the automatic valves of a rigid airship when docked in the shed. Jam pot cover (British).
- veneer**—Thin sheets of wood, either sliced with a knife or sawed.
- vent, pressure-relief**—A small opening in the covering of the fin of an airship intended to facilitate the equalization of the pressure of the air within the fin with that of the outside air. It also provides an outlet for any gas that may collect in the fin.
- Venturi, power**—A Venturi tube used to operate gyroscopic turn indicators and other instruments.
- Venturi, speed-indicating**—A Venturi tube may be combined with a Pitot tube or with a tube giving static pressure to form a pressure nozzle which may be used to determine the indicated speed of an aircraft through the air. The pressure difference is measured by a suitable gauge.
- Venturi tube**—A short tube with flaring ends and a narrow or constricted section between them, into which a side tube opens. When fluid flows through the Venturi, there is a reduction of pressure in the constricted section, the amount of the reduction being a function of the velocity of flow. (Fig. 8.)
- vertical engine**—See ENGINE, VERTICAL.

- vertimeter**—A device for indicating the rate of rise and fall of an aerostat, usually a special form of statescope. A rate-of-climb meter serves the same purpose, although of a different form.
- volume**—The volume of the air displaced by the gas used for inflation.
- volume, aerodynamic (airship)**—The volume of the form which must be driven through the air. Same as "air volume."
- volume, air (airship)**—The volume of air displaced by the body formed by the outer cover or envelope of an airship. It is this volume which enters into aerodynamic computations. See VOLUME, AERODYNAMIC (AIRSHIP).
- volume, gas (airship)**—The volume of the contained gas. See CAPACITY.
- V-type engine**—See ENGINE, V-TYPE.
- V-wires**—The lower lines of the winch suspension of the kite balloon. They meet at the junction piece and form V's; hence the name. (Fig. 2.)
- walkway girder**—See GIRDER, WALKWAY.
- warp**—To change the form of a wing by twisting it. Warping is sometimes used to maintain the lateral equilibrium of an airplane.
- wash**—The disturbance in the air produced by the passage of an airfoil. Also called the "wake" in the general case for any solid body.
- washin**—Permanent warping of the wing which results in an increase in the angle of attack near the tip.
- washout**—Permanent warping of a wing which results in a decrease in the angle of attack near the tip.
- water-recovery apparatus**—See APPARATUS, WATER-RECOVERY.
- water-recovery condenser**—See CONDENSER, WATER-RECOVERY.
- weight, dischargeable (consumable weight) (airship)**—All weight which can be consumed or discharged and still leave the airship in safe operating condition with a specified reserve of fuel, oil, water ballast, and provisions, and her normal crew.
- weight, disposable (airship)**—All weight other than fixed weights, including dischargeable weights contrasted with fixed weights, q. v.
- weight, empty**—The structure, power plant, and fixed equipment of an aircraft. Included in this fixed equipment are the water in the radiator and cooling system, all essential instruments and furnishings, fixed electric wiring for lighting, heating, etc. In the case of the aerostat the amount of ballast which must be carried to assist in making a safe landing must also be included.
- weight, fixed (airship)**—The weight of the hull machinery and all equipment and parts which are fixed in position and nonconsumable. All constant and nonconsumable weights which an airship would carry under all conditions of service (British). Liquids in cooling systems of engines are included.
- weight, fixed power-plant, for a given airplane**—The weight of an engine, including ignition, carburetor, and induction systems complete, propeller and hub, exhaust manifolds, radiator and water, *if used*, with all interconnecting wires, controls, tanks, and pipes, lubricating-oil temperature regulators, *the oil contained in the engine crankcase* and the starting gear attached to the engine, but excluding fuel, oil, and engine instruments.
- weight per horsepower**—The dry weight of an engine divided by the rated horsepower.
- winch, suspension**—See SUSPENSION WINCH.
- windmill**—An air-driven screw used to drive auxiliary apparatus on an aircraft.
- window, inspection**—A small transparent window fitted in the envelope of a balloon or airship, or in the wing of an airplane, to allow inspection of the interior. (Figs. 1 and 3.)
- wind, relative**—The motion of the air with reference to a body, i. e., its motions as observed by a man at rest on the body. The direction and velocity of the relative wind, therefore, are found by adding two vectors, one being the velocity of the air with reference to the earth, the other being equal and opposite to the velocity of the body with reference to the earth.

- wind tunnel**—An elongated chamber, usually a tube divergent at the ends, through which a steady air stream may be drawn or forced. Models of airfoils, of aircraft, or of propellers may be placed in the middle portion of the tunnel, called the experiment chamber or working section, and supported by suitable balances placed outside the air stream, so that the forces, moments, etc., due to the moving air may be measured.
- wing**—A general term applied to a whole or a portion of the main supporting surfaces of an airplane, but in the latter case is usually qualified as right wing, left wing, upper wing, or lower wing, etc.
- wing car**—See CAR, WING.
- wing-dihedral angle**—See ANGLE, WING-DIHEDRAL OR DIHEDRAL.
- wing drag**—See DRAG.
- wing-heavy**—The condition of an airplane in which (in normal flight) there is a tendency for the right (or left) wing to drop, if the lateral control is released, i. e., the condition in which the pilot has to exert a lateral force on the control stick to keep the lateral axis horizontal.
- wing loading**—See LOADING, WING.
- wing rib**—A fore-and-aft member of the wing structure of an airplane, used to give the wing section its form and to transmit the load from the fabric to the spars. (Figs. 1 and 15.)
- rib compression**—A heavy rib designed to have the function of a wing rib and also to act as a strut opposing the pull of the wires in the internal drag-truss. (Also called "Drag strut.") (Figs. 1 and 15.)
- rib, former or false**—An incomplete rib, frequently consisting only of a strip of wood extending from the leading edge to the front spar, which is used to assist in maintaining the form of the wing where the curvature of the airfoil section is sharpest. (Figs. 1 and 15.)
- wing setting, angle of**—See ANGLE OF WING SETTING.
- wing skid**—See SKID.
- wing spar**—The principal transverse structural member of the wing assembly of an airplane (Figs. 1 and 15.)
- wing truss**—The framing by which the wing loads of an airplane are transmitted to the fuselage. It comprises struts, wires, cables, tie rods, and spars.
- wire**—In aeronautics, refers specifically to drawn solid wire.
- wire (airship):**
- antiflutter**—A wire in the plane of the outer cover for locally reinforcing the outer cover in that part of the airship and reducing fluttering in flight due to air pressure or propeller wash. Also called "outer cover support wire."
  - chord**—A wire joining the vertices of the polygonal frame of the main transverse frame. (Fig. 4.)
  - diametral**—A chord wire which passes through or near the center of the main transverse frame. It is usually attached to the axial fitting. (Fig. 4.)
  - fairing**—A wire provided as a point of attachment for the outer cover to maintain the contour lines of the envelope of an airship.
  - main shear**—A diagonal wire taking up mean shear loads in the structure of a rigid airship.
  - netting**—Diagonal and/or circumferential wire netting fitted between the longitudinals over the entire hull of a rigid airship, to transmit the lift of the gas cells to the structure. Sometimes called "gas pressure wires." (Fig. 4.)
  - radial**—A wire which extends from an axial fitting at the center of the transverse frame of a rigid airship to a joint of the frame.
  - secondary shear**—Additional reinforcing shear wire.
- wire, antidiag**—A wire designed primarily to resist forces acting parallel to the chord of the wing of an airplane and in the same direction as the direction of flight. It is generally inclosed in the wing. (Fig. 1.)

- wire, drag**—Any wire or cable designed primarily to resist drag forces.
- internal**—A drag wire concealed inside the wing. (Fig. 1.)
- external**—A drag wire run from a wing to the fuselage or other part of the airplane. (Fig. 1.)
- wire, landing**—A wire designed primarily to resist forces in the opposite direction to the normal direction of the lift and to oppose the lift wire and prevent distortion of the structure by an overtightening of those members. (Fig. 1.) Sometimes called "antilift" wire.
- wire, lift**—A wire or cable which transmits the lift on the outer portion of the wing of an airplane in toward the fuselage or nacelle. This wire usually runs from the top of an interplane strut to the bottom of the strut next nearer the fuselage. Sometimes called "flying wire." (Fig. 1.)
- wire, stagger**—A wire connecting the upper and lower surfaces of an airplane and lying in a plane substantially parallel to the plane of symmetry. (Also called "incidence wire.") (Fig. 1.)
- wood, laminated**—A product formed by gluing or otherwise fastening together a number of laminations of wood with the grain substantially parallel. (Differs from plywood in that in the latter the grain of alternate plies is usually crossed at right angles; also, the plies of the latter are usually made up of veneer.)
- W-type engine**—See ENGINE, W-TYPE.
- yaw, angle of**—See ANGLE OF YAW.
- yaw guy**—See LINE, YAW.
- yaw line**—See LINE, YAW.
- yawmeter**—An instrument for measuring the angle of yaw.
- zero-lift angle**—See ANGLE, ZERO-LIFT.
- zero-lift line**—A line through the trailing edge of an airfoil section parallel to the direction of the wind when the lift is zero.
- zoom**—To climb for a short time at an angle greater than that which can be maintained in steady flight, the airplane being carried upward at the expense of its kinetic energy. This term is sometimes used as a noun, to denote any sudden increase in the upward slope of the flight path.

## REPORT No. 240

### NOMENCLATURE FOR AERONAUTICS

By The NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

#### PART II

#### NOMENCLATURE BY DIVISIONS

##### A. GENERAL TERMS

**aerodynamics**—The branch of dynamics which treats of the motion of air and other gaseous fluids and of the forces acting on solids in motion relative to such fluids.

**aeronautics**—The science and art pertaining to the flight of aircraft.

**aerostatics**—The science that treats of the equilibrium of gaseous fluids and of solid bodies immersed in them.

As an aeronautic term, it relates to those properties of lighter-than-air craft which are due to the buoyancy of the air.

**aerostation**—The art of operating aerostats.

**aircraft**—Any weight-carrying device or structure designed to be supported by the air, either by buoyancy or by dynamic action.

**airport**—A locality, either of water or land, which is adapted for the landing and taking off of aircraft and which provides facilities for shelter, supply, and repair of aircraft; or a place used regularly for receiving or discharging passengers or cargo by air.

**airway**—An air route between air traffic centers which is over terrain best suited for emergency landings, with landing fields at regular intervals equipped with aids to air navigation and a communication system for the transmission of information pertinent to the operation of aircraft.

The term "airway" may apply to an air route for either landplanes or seaplanes or both.

**aviation**—The art of operating heavier-than-air craft.

**cross-country flight**—A flight which necessitates leaving the vicinity of a regular landing field.

**pilot**—An operator of aircraft. This term is applied regardless of the sex of the operator.

##### B. TYPES OF AIRCRAFT

**aerostat**—A generic term for aircraft whose support is chiefly due to buoyancy derived from aerostatic forces. The immersed body consists of one or more bags, cells, or other containers, which are filled with a gas which is lighter than air.

**Syn.**—LIGHTER-THAN-AIR CRAFT. Includes airship and balloon, q. v.

**airplane**—A mechanically driven aircraft, heavier than air, fitted with fixed wings, and supported by the dynamic action of the air. (Figs. 1, 6, 9, 10, and 14.)

**glider**—A form of aircraft similar to an airplane, but without a power plant.

**helicopter**—A form of aircraft whose sole support in the air is derived directly from the vertical component of the thrust produced by rotating airfoils.

**kite**—An aircraft heavier than air, restrained by a towline and sustained by the relative wind.

**ornithopter**—A form of aircraft heavier than air, deriving its chief support and propelling force from flapping wings.

## C. TYPES OF AEROSTATS

**airship**—An aerostat provided with a propelling system and with means of controlling the direction of motion. When its power plant is not operating, it acts like a free balloon.

**nonrigid**—An airship whose form is maintained by the internal pressure in the gas bags and ballonets. (Fig. 3.)

**rigid**—An airship whose form is maintained by a rigid structure. (Fig. 4.)

**semirigid**—An airship whose form is maintained by means of a rigid or jointed keel in conjunction with the internal pressure in the gas containers and ballonets. (Fig. 5.)

The term "airship" is sometimes incorrectly applied to heavier-than-air craft either in full or as "ship." This is a slang use of the word and should be avoided.

**balloon**—An aerostat without a propelling system.

**barrage**—A small captive balloon used to support wires or nets which are intended as a protection against attacks by aircraft.

**captive**—A balloon restrained from free flight by means of a cable attaching it to the earth.

**constant pressure\***—A supply balloon arranged to maintain a constant pressure of gas in a moored or docked aerostat.

**free**—A balloon, usually spherical, whose ascent and descent may be controlled by use of ballast or with a loss of the contained gas and whose direction of flight is determined by the wind. (Fig. 11.)

**kite**—An elongated form of captive balloon fitted with lobes to keep it headed into the wind and usually deriving increased lift due to its axis being inclined to the wind. (Fig. 2.)

**nurse\***—Sometimes used to refer to a constant-pressure balloon.

**observation**—A captive balloon used to provide an elevated observation post.

**pilot\***—A small balloon sent up to show the direction and speed of the wind.

**propaganda**—A small free balloon sent up without passengers but with a device by which papers or documents may be dropped at intervals.

**sounding\***—A small balloon sent up without passengers but with recording meteorological instruments.

**supply\***—A container made of heavy fabric employed as a portable means of storing gas at low pressure. It is usually too heavy to rise even if free.

**triangulation**—A small captive balloon used as a mark on which to sight in a triangulation survey.

## D. TERMS RELATING TO AEROSTATS

## (a) OPERATION

**ballast**—Any substance, usually sand or water, carried in a balloon or airship and intended to be thrown out, if necessary, for the purpose of reducing the load carried and thus altering the aerostatic relations. (Figs. 4 and 5.)

**bow-heavy**—The condition of an airship which, when at rest in still air, trims with its axis inclined down by the bow. The term "bow-heavy" is preferred to "nose-heavy" in describing airships.

**breathing**—The passage of air into or out of an aerostat, due to the changing of its volume.

**breathing stresses**—Stresses produced in an aerostat by breathing. Of importance in the envelope and keel of a semirigid airship due to the interaction of envelope and keel when the envelope "breathes."

**danger cone**—A pennant on the wire cable of a captive balloon to warn aircraft of its presence. Usually a hollow cone of light cloth.

**deflation**—The act of removing gas and air from an aerostat.

**deflation sleeve**—Generally a sleeve or appendix made of fabric provided for the special purpose of facilitating the deflation of an aerostat. Also applied to the sleeve or appendix fitted in the lower lobe of a kite balloon and used to permit the rapid escape of air in the lobes when the balloon is hauled down. (Fig. 2.)

\*Those forms of balloons marked with an asterisk (\*) are not, strictly speaking, aircraft.

## D. TERMS RELATING TO AEROSTATS—Continued

## (a) OPERATION—Continued

- gassing**—The operation of replenishing a balloon with fresh gas to increase the purity or to make up for a loss of gas.
- gassing factor**—The quantity of aerostatic gas required to maintain an aerostat for one year. It is ordinarily expressed as a percentage of the gas volume.
- hog**—A distortion of an airship in which the longitudinal axis becomes convex upward so that both ends droop.
- inflation**—The act of filling a balloon or airship with gas.
- sag**—A distortion of an airship in which the longitudinal axis becomes concave upward so that both ends rise.
- stern-droop**—A deformation of an airship in which its longitudinal axis bends downward at the after end.
- stern-heavy**—The condition in which, in normal flight, the after end of an airship tends to sink and which requires correction by means of the horizontal controls. In this condition an airship is said to "trim by the stern." It may be due to either aerodynamic or static conditions or to both.
- superheat**—The amount by which the temperature of the gas in the envelope or gas cells of an aerostat is higher than the temperature of the surrounding air. If the contained gas has a lower temperature, the superheat is said to be negative.
- trim**—The attitude of an aerostat relative to a fore-and-aft horizontal plane. If the forward end is down, the aerostat is said to have "trim by the bow;" if the after end, it has "trim by the stern."
- trim, to**—To alter the attitude of an aerostat relative to fore-and-aft horizontal plane. If the endeavor is to force the bow down, the aircraft is "trimmed by the bow;" if the stern, it is "trimmed by the stern." If the aircraft shows a tendency to sink by the bow end, it is said to "trim by the bow" or to be "bow-heavy;" if the tendency is to sink by the stern, it is said to "trim by the stern" or to be "stern-heavy."

## (b) PRINCIPAL PARTS

- ballonet**—A compartment of variable volume constructed of fabric, or partitioned off, within the interior of a balloon or airship. It is usually partially inflated with air, under the control of valves, from a blower or from an air scoop. By the blowing in or letting out of air, it serves to compensate for changes of volume in the gas contained in the envelope and to maintain the gas pressure, thus preventing deformation or structural failure. By means of two or more ballonets, often used in nonrigid airships, the trim can also be controlled. The ballonet should not be confused with gas cell. (Figs. 2, 3, and 5.)
- ballonet diaphragm**—The fabric partition between the gas and air compartments of the envelope of a nonrigid or semirigid airship or kite balloon.
- basket**—The structure suspended beneath a balloon for carrying passengers, ballast, etc. (Figs. 2 and 11.) It is usually used on a free or kite balloon.
- bow-cap**—(1) A cap of metal or fabric used to reinforce the extreme forward ends of the bow stiffeners of a nonrigid or semirigid airship. (Figs. 3 and 5.)  
(2) The conical or cap-shaped structure at the extreme bow of a rigid airship to which the longitudinal girders are attached and which supports the bow mooring spindle. (Fig. 4.)
- bow-stiffener**—A rigid member attached to the bow of a nonrigid or semirigid envelope to reinforce it against the pressure caused by the motion of the airship. Sometimes called "nose stiffener" or "nose batten." (Figs. 3 and 5.)
- car**—That portion of an airship which is intended to carry power unit or units, personnel, cargo or equipment. It may be suspended from the buoyant portion or it may be built close up against it. It is not to be applied to parts of the keel of a rigid or semirigid airship which have been fitted for the purposes mentioned. (Figs. 3, 4, 5, 12, and 13.)

## D. TERMS RELATING TO AEROSTATS—Continued

## (b) PRINCIPAL PARTS—Continued

- control car**—The car of an airship in which controls are centralized and from which it is operated. (Figs. 3, 4, 5, 12, and 13.)
- control compartment**—A compartment in the control car of an airship from which all controls are operated. It may be compared to the pilot house of a ship.
- envelope**—The outer covering of an aerostat, usually of fabric. It may or may not be also the gas container. It may be divided by diaphragms into separate gas compartments or cells, and it may also contain internal air cells or ballonets. (Figs 2, 3, 4, 5, 11, 12, and 13.)
- gas cell**—One of the gas-containing units fitted in a rigid airship. Sometimes called "gas bag." (Fig. 4.)
- gore**—The portion of the envelope of a balloon or airship included between two adjacent meridian seams.
- hull**—The main structure of a rigid airship, consisting of a covered elongated framework which incloses the gas cells and supports the cars and equipment. (Fig. 4.) May also be applied to the complete buoyant unit of any aerostat. In this latter sense sometimes called "gas bag."
- intermediate longitudinal**—An intermediate longitudinal strength member, of a rigid airship, which lies between two adjacent main longitudinals and is generally of lighter weight and/or smaller dimensions than the main longitudinals. (Fig. 4.)
- intermediate transverse**—An open unbraced transverse frame of a rigid airship which lies between two main or braced transverse frames. (Fig. 4.)
- keel**—The assembly of members at the bottom of the hull of a semirigid or rigid airship which provides special strength to resist hogging and sagging and also serves to distribute the effect of concentrated loads along the hull. It may be a simple Gall's chain, as in some semirigids, or a very extensive structure inclosing the corridor, as in most rigids. (Figs. 4 and 5.)
- lobe**—An air or gas inflated bag fitted at the stern of a kite balloon and acting as a fin or stabilizer to give it aerodynamic stability. (Fig. 2.)
- main longitudinal**—A main longitudinal strength member, of a rigid airship, which connects the various transverse frames. (Fig. 4.)
- main transverse**—A main transverse strengthening frame of a rigid airship provided with wire or girder bracing and spaced at regular intervals throughout the length of the airship. (Fig. 4.)
- observation platform**—A platform or small deck fitted on the top of an airship and used as a post for a lookout and defense, or as a place from which to make observations used in navigating the airship. (Figs. 4 and 5.)
- outer cover**—The outside covering of a hull of a rigid airship, usually of some kind of fabric. Sometimes called the "envelope." (Figs. 4 and 5.)
- sighting pendant**—A vertical wire on center line and forward of the control car of an airship, used as a mark in steering, to assist in determining wind direction.
- stern framing**—All framework, aft of the cruciform girder, necessary to complete the shape and contour of a rigid airship.
- wing car**—A car suspended off the center line of an airship. It is also called "side car." (Fig. 4.)
- wire:**
- antiflutter**—A wire in the plane of the outer cover for locally reinforcing the outer cover in that part of the airship and reducing fluttering in flight due to air pressure or propeller wash. Also called "outer cover support wires."
  - chord**—A wire joining the vertices of the polygonal frame of the main transverse frame. (Fig. 4.)
  - diametral**—A chord wire which passes through or near the center of the main transverse frame. It is usually attached to the axial fitting. (Fig. 4.)

## D. TERMS RELATING TO AEROSTATS—Continued

## (b) PRINCIPAL PARTS—Continued

wire—continued.

**fairing**—A wire provided as a point of attachment for the outer cover to maintain the contour lines of the envelope of an airship.

**main shear**—A diagonal wire taking up main shear loads in the structure of a rigid airship.

**netting**—Diagonal and/or circumferential wire netting fitted between the longitudinals over the entire hull of a rigid airship to transmit the lift of the gas cells to the structure.

Sometimes called "gas pressure wires." (Fig. 4.)

**radial**—A wire which extends from an axial fitting at the center of the transverse frame of a rigid airship to a joint of the frame.

**secondary shear**—Additional reinforcing shear wire.

## (c) DETAILED PARTS AND FITTINGS

**air duct**—A tube, usually of fabric, supplying air for filling or for maintaining pressure in air-filled parts of an aerostat.

(a) The duct joining the vertical and lateral lobes of a kite balloon. Sometimes called "interconnecting sleeve" or "trousers" (British). (Fig. 2.)

(b) The duct leading from the air scoop or blower of a nonrigid or semirigid airship to the ballonnet or ballonets. (Figs. 2 and 5.)

**air scoop**—A projecting scoop which uses the wind or slip stream to maintain air pressure in the interior of the ballonnet of an aerostat. (Figs. 2, 3, and 12.)

A similar device is sometimes used on airplanes to produce ventilation. (Fig. 4.)

**appendix**—The tube, usually located at the bottom of a balloon, primarily used for inflation and deflation. In the case of a free balloon it may also serve as an automatic discharge opening. (Fig. 11.)

Originally applied to free balloons only. Should be restricted to the various types of balloons and not applied to airships.

**appendix manhole**—An appendix of large diameter and usually rather short. It is used more for access than for inflation or deflation. (Fig. 2.)

**automatic valve**—A spring-loaded relief valve fitted to the envelope, ballonnet, or gas cell of an aerostat and set to open at a predetermined pressure for the purpose of preventing excessive internal pressure. (Figs. 4 and 5.)

Also applied to a type of valve used on some aerostats which opens at a predetermined contained volume or hull dimension.

**axial cable**—The axial member (usually steel wire cable) sometimes fitted in a rigid airship. It is attached to the central fitting of the radial or diametral wires of each main transverse and to the hull structure at bow and stern. Its purpose is to provide support for the radial or diametral wires in an axial direction and thus assist them to sustain the load which might be caused by unequal pressure in adjacent cells or by the airship being pitched to a large angle. (Fig. 4.)

**axial cone**—The cone-shaped fabric fitting in the end of a gas cell of a rigid airship, which provides a gas-tight connection of the cell to the axial cable and yet permits the cell some degree of freedom in its movements. A special form of conical sleeve. (Fig. 4.)

**band:**

**mooring**—A band of tape or webbing over the top of a kite balloon to which the mooring ropes are attached. It forms part of a mooring harness. (Fig. 2.)

**suspension**—A horizontal fabric band securely fastened to the envelope of a balloon or airship and to which are attached the main suspensions of the basket or car, or the captive cable of a kite balloon. (Fig. 2.)

**trajectory**—A band of webbing carried in a special curve over the surface of the envelope of an airship to distribute the stresses due to the suspension of the car. (Fig. 13.)

## D. TERMS RELATING TO AEROSTATS—Continued

## (c) DETAILED PARTS AND FITTINGS—Continued

- batonet**—A special form of toggle, usually quite slender and truly cylindrical except for the groove, and used to attach the rigging of a balloon or airship to a fabric loop or suspension band on the envelope.
- box girder**—Any girder of rectangular section. Frequently used to refer to the rectangular, longitudinal members in the keel of a rigid airship from which fuel tanks and gas bags are suspended.
- bridle**—A sling of cordage or wire which has its ends fixed at two different points, to the bight of which a single line may be attached, either movably or fixed, thus distributing the pull of the single line to two points or more in the case of a multiple bridle. This term is also used to refer to a towing or mooring line having two legs and intended to reduce yawing when towing or mooring.
- bullseye**—A circular thimble.
- catenary**—A line or length of cordage which is secured to or in a piece of fabric in the form of a catenary curve or a series of such curves. (Fig. 5.)
- chafing patch**—A patch of fabric secured to the envelope of an aerostat to protect it from abrasion.
- channel patch**—A channel-shaped fabric-fitting secured to the envelope of an aerostat to allow a rod or spar to be laced to the envelope.
- climbing shaft**—An access shaft fitted with a ladder and leading from the bottom to the top of an airship hull. This may be fitted to an airship of any type. (Figs. 4 and 5.)
- concentration ring:**
- airship**—A ring to which several rigging lines are led from the envelope and from which one or more lines also lead to the car.
  - free balloon**—A ring to which are attached the ropes suspending the basket and to which the net is also secured. Sometimes called "load ring." (Fig. 11.)
- conical sleeve**—A cone-shaped fabric, fitting in a bag or cell through which a line passes. It provides a gas-tight connection of the bag or cell to the line and yet permits both some degree of freedom to move.
- control lines**—Lines of wire and/or stranded cable leading from the control car or compartment to the various parts of an airship, and operating either through mechanisms or directly, the rudders, valves, etc., which control the speed, altitude, etc., of the airship.
- cradle:**
- building**—A support provided for the frame of a rigid airship or the keel of a semirigid airship during construction.
  - docking**—A support for the car of an airship while it is being inflated in the shed. Mostly used with rigid airships.
- crow's-foot**—A system of diverging short ropes for distributing the pull of a single rope.  
An arrangement in which the strands of a cord are opened out so that they can be effectively cemented to a fabric surface.
- cruciform girder**—The structure, consisting of vertical and horizontal transverse girders, which is fitted at the stern of a rigid airship for the purpose of supporting the inboard ends of the sternposts of the fins or the rudderposts. It may be integral with the sternposts which form the after ends of the fins.
- drag rope**—A long rope which can be hung overboard from a balloon so as to act as a brake and a variable ballast in making a landing. Same as "trail rope" or "guide rope." On airships a similar rope, or ropes, is used as a haul-down or mooring line by the landing crew. It is usually larger and longer than the regular handling lines. Sometimes called "grab line."
- drip flap**—A strip of fabric attached by one edge to the envelope of an aerostat so that rain runs off its free edge instead of dripping into the basket or car. It also assists in keeping the suspension ropes dry and nonconducting. Also called "drip band" and "drip strip."

## D. TERMS RELATING TO AEROSTATS—Continued

## (c) DETAILED PARTS AND FITTINGS—Continued

**D-ring**—A ring having (as the name implies) the shape of a capital D, to which rope suspensions are attached.

**field-handling frame**—A portable frame which may be attached to an airship when it is on the ground and which is intended to afford a grasp to more men than could get on the handling rails of the cars. These frames are rarely carried when in flight. (Fig. 4.)

**finger patch**—A special form of patch having extensions or “fingers” extending out from the central portion. The “fingers” may be of tape, frayed-out rope, or fabric. Their function is to distribute the load more widely to the fabric of the envelope or gas cells. (Fig. 12.)

**fin carrier**—A frame to which the inboard edge of the fin of a nonrigid or semirigid airship is attached, so as to prevent the edge of the fin from sinking into the envelope.

**fin girder**—A girder of a rigid airship which goes to make up the fin.

**gas shaft**—A duct or shaft leading from the bottom of the gas cells to the outer cover of an airship. It affords a clear passage for the escape of gases which have accumulated in the gangway or corridor, or which are discharged from the valves at the bottom of the cells. It usually consists of light wooden hoops or frames spaced at intervals on cords or wires, and is covered by a netting. It prevents the gas cells from closing hard against one another and thus keeps the passage open. Sometimes called “gas trunk,” “exhaust-gas shaft,” or “trunk.”

In view of the possibility of confusion with parts of an engine-exhaust system, it is believed that “gas shaft” or “trunk” is to be preferred. (Fig. 4.)

**gas-shaft hood**—A hood or cowl, located on the outer cover of a rigid airship at the outer end of a gas shaft. It is usually made of light wood and fabric and is faced to facilitate the escape of gas. Sometimes called “exhaust-gas hood.”

In view of the possibility of confusion with the parts of an engine exhaust system, it is believed that “gas-shaft hood” is to be preferred. (Fig. 4.)

**gland**—A short tube fitted to an envelope or gas bag in such a manner that a rope or line may slide through without leakage of gas or air. (Figs. 2 and 5.)

**grommet**—A small ring of chord.

**handling line**—A line attached along the side of an airship for use in maneuvering near and on the ground. (Figs. 2, 3, 4, and 5.) Sometimes called “grab line.”

**inflation manifold**—A metal or fabric connection with numerous inlets which permit the passage of gas at the same time from a number of sources (either cylinders or gas holders) to the main inflation tube.

**inflation sleeve (or filling sleeve)**—A tubular fabric attachment to an envelope or gas bag, serving as a lead for the inflation tube. (Figs. 3 and 5.)

**inflation tube**—A fabric tube leading from the inflation manifold or source of supply to the inflation sleeve of the gas cell or envelope.

**jackstay**—A longitudinal rigging provided to maintain the correct distance between various parts or fittings on an aerostat.

**main mooring line**—The line dropped from the bow of an airship to be coupled to the mast main mooring line. (Fig. 4.)

**maneuvering valve**—A manually operated valve fitted to the envelope, ballonet, or gas cell of an aerostat for the purpose of releasing gas or air from within the envelope or gas cell when desired. (Fig. 4.)

**maneuvering-valve hood**—A hood, or cowl, located on the outer cover of a rigid airship just over a maneuvering valve. It is usually made of light wood or fabric and is faced to facilitate the escape of gas. (Fig. 4.)

**manometer-tube gland**—A gland fitted to the envelope of an aerostat to form a gas-tight connection for the tube leading to the manometer in the car. Same as “pressure-tube gland.”

**D. TERMS RELATING TO AEROSTATS—Continued****(c) DETAILED PARTS AND FITTINGS—Continued**

- mooring cone**—The grooved conical member at the extreme bow of an airship which engages with a hollow cone at the top of the mooring mast and provides the coupling between the airship and the mooring mast. (Fig. 4.)
- mooring-cone outrigger**—The member, usually tubular, which supports the mooring cone at the bow of the airship. Sometimes referred to as "mooring spindle." (Fig. 4.)
- mooring harness**—A system of webbing bands, fitted over the top of the envelope of a balloon, to which are attached the mooring ropes. Usually found only in kite balloons or observation balloons. (Fig. 2.)
- mooring line**—A line attached near the bow of an airship for securing it to the ground or to a mooring mast. (Figs. 3, 4, and 5.)
- mooring ring**—A metallic ring suspended from one of the forward frames of a rigid airship by wire lines and used for mooring. The vertex of a "three-point mooring" is attached to this ring.
- mooring rope**—A line attached to a balloon or airship for use in securing it to the ground. It may serve the purpose of a "handling line," or vice versa. (Fig. 2.)
- net:**
- free-balloon**—A rigging made of ropes and twine shaped to the upper surface of the envelope, which supports the weight of the basket, etc., and distributes the load over the entire upper surface of the envelope. (Fig. 11.)
- gas-cell (rigid airship)**—A netting of cord of small mesh which is intended to assist the fabric of the gas cells in transmitting gas force to a wire netting of coarser mesh and to the longitudinals, both being fitted between the longitudinals. It may be compared to the net of a free balloon. Sometimes called "gas-cell netting" or "cord netting." (Fig. 4.)
- inflation**—A rectangular net of cordage used to restrain the envelope of the kite balloon or airship during inflation. Also applied to a free-balloon net designed to be removed after inflation.
- patch**—A strengthened or reinforced flap of fabric of special shape and construction, which is cemented to the envelope or gas cell. It usually forms an anchor by which some portion of the structure may be attached to the envelope or to which the positioning lines, controlling the gas cell, may be attached to the cell. (Fig. 12.)
- pressure flap**—A flap valve fitted in the outer cover or envelope of a rigid airship and arranged to permit the rapid flow of air in and out, particularly inward. The purpose is to facilitate the rapid equalization of the pressure of the air within the envelope with that of the surrounding air.
- pressure-relief vent**—A small opening in the covering of the fin of an airship intended to facilitate the equalization of the pressure of the air within the fin with that of the outside air. It also provides an outlet for any gas that may collect in the fin.
- pressure tube**—A tube fitted to an envelope of a gas bag, to which a pressure gauge may be attached.
- propeller reinforcing girder**—A light additional member fitted in the structure of a rigid airship to reinforce those areas of the outer cover which are affected by the propeller wash.
- quadrant**—The operating lever, made on the arc of a circle of a control surface of an airship, e. g., rudder quadrant, elevator quadrant. (Fig. 4.)
- rip cord**—The rope running from the rip panel to the car or basket, the pulling of which tears off or rips the rip panel and causes immediate deflation. (Figs. 2 and 3.)
- rip panel**—A strip of fabric inserted or fitted in the upper part of the envelope of a balloon or semirigid or nonrigid airship which is torn or ripped open when immediate deflation is desired. (Figs. 2 and 3.)

## D. TERMS RELATING TO AREOSTATS—Continued

## (c) DETAILED PARTS AND FITTINGS—Continued

- rudder (airship)**—A hinged or pivoted surface, usually attached to a fin at the after end of an airship. When operated by the pilot it produces a yawing moment and gives directional control in the plane at right angles to the axis about which it is hinged or pivoted. (Figs. 3, 4, and 5.)
- safety loop**—A loop formed in a rip cord and attached to a securing patch by a breakable cord or a spring clip. It may be formed either inside the envelope and close to the rip panel, or outside the envelope near the gland by which the rip cord passes through the envelope. Before the rip panel can be "pulled" the breakable cord must be broken or the clip opened. Accidental "pulling" is thus made unlikely, as the weight of the cord is easily carried by the breakable cord or spring clip.
- sandbag line**—A rope extending along the line of suspension ropes or bridles of a kite balloon to which are hooked the sandbags used in mooring the balloon. The purpose is to prevent wear on the suspension cordage.
- sandbag loop**—A system of cordage loops on the envelope of a balloon for suspending sandbags. See also SANDBAG LINE.
- sea anchor**—An open fabric bag carried on an aircraft and arranged to offer considerable resistance when towed mouth first through the water. Tripping or collapsing devices may be incorporated in it. Also called "drogue."
- supply tube**—An elongated appendix or inflation sleeve, fitted on a kite balloon, which is brought down to the basket and fitted with a quick-connection coupling. This coupling can be attached to a similar piece on the deck of the airship and gas may be sent into the balloon shortly after it has reached the deck. A similar tube is sometimes used with airships where constant pressure nurse balloons are used. This is rare in the United States. (Fig. 2.) Also called "nursing tube."
- suspension bar**—A bar to which the supporting ropes of the basket of a balloon are secured. It is also fitted with ropes and toggles for attaching to the basket suspensions from the balloon. Also called "trapeze bar." (Figs. 2 and 11.)
- suspension line**—A line either of cordage or metal which supports the weight attached to the envelope of a balloon or airship. (Figs. 2, 3, 4, 5, and 11.)
- suspension patch**—A patch, secured to the envelope or to a gas cell of an aerostat, to which a suspension line may be attached. (Fig. 12.)
- thimble**—A grooved ring of circular, pear-, or heart-shaped form, generally of metal, which is inserted in the eye of a rope or wire to prevent chafing or deformation of the eye.
- toggle**—A short crossbar of wood or metal which is fitted at the end of a rope. The rope passes around the mid-length of the bar in a shouldered groove. By slipping it through an eye in the end of another rope, the two lengths of rope can be quickly connected or disconnected. (Fig. 2.)
- topping up**—The operation of filling up with gas an already partially full aerostat. Also applied to a similar operation with fuel tanks. Incorrectly called "nursing."
- valve hood**—The appliance, having the form of a hood or parasol which protects the valve of an airship or balloon against rain. Also called "valve cover" or "bonnet." (Figs. 2, 4, and 5.)
- valve petticoat**—A special sleeve between valve and gas container making it possible to tie off the sleeve and change valves without loss of gas.
- valve seal**—A fabric cover used to seal the automatic valves of a rigid airship when docked in the shed. Jam pot cover (British).
- V-wires**—The lower lines of the winch suspension of the kite balloon. They meet at the junction piece and form V's; hence the name. (Fig. 2.)
- walkway girder**—The girder forming the support of a walkway through the keel or in other localities in a rigid or semirigid airship. (Fig. 4.)

**D. TERMS RELATING TO AEROSTATS—Continued****(c) DETAILED PARTS AND FITTINGS—Continued**

**winch suspension**—The rigging by means of which the lift and drag of a kite balloon is transmitted from the envelope to the towing or traction cable. (Fig. 2.)

**yaw line**—A line dropped from the bow of an airship when mooring to the mast to act as a steadying line to prevent yawing and overriding the mast. Also called "bow-steadying line" or "yaw guy." ("Side guy wire," British.)

**(d) MISCELLANEOUS TERMS**

**aerodynamic volume**—The volume of the form which must be driven through the air. Same as AIR VOLUME.

**air volume**—The volume of air displaced by the body formed by the outer cover or envelope of an airship. It is this volume which enters into aerodynamic computations. See AERODYNAMIC VOLUME.

**air-volume displacement (or aerodynamic-volume displacement)**—The weight of a mass of air equal to the aerodynamic volume of the airship in N. A. C. A. standard atmosphere at sea level.

**buoyancy**—The upward air force on an aerostat which is derived from aerostatic conditions. It is equal to the weight of the air displaced.

**capacity**—The volume of the gas-containing portion of an aerostat.

**center of buoyancy**—The center of gravity of the volume of the contained gas.

**dischargeable weight (consumable weight)**—All weights which can be consumed or discharged and still leave the airship in safe operating condition with a specified reserve of fuel, oil, water ballast and provisions, and her normal crew.

**displacement**—The mass of air displaced by the gas used for inflation. It may be expressed as a weight of volume. In the latter case it is usually called "volume."

**disposable weight**—All weights other than fixed weights, including dischargeable weights contrasted with fixed weights, q. v.

**fixed weight**—The weight of the hull machinery and all equipment and parts which are fixed in position and nonconsumable. All constant and nonconsumable weights which an airship would carry under all conditions of service (British). Liquids in cooling systems of engines are included.

**gas volume**—The volume of the contained gas. See CAPACITY.

**gross lift**—The lift obtained from a volume of buoyant gas equal to the nominal gas capacity of the aircraft. Obtained by multiplying the nominal gas capacity by the lift per unit volume of the gas used for inflation.

**lift (of a gas)**—The difference of density of air and the gas. Both are supposed to be under the same conditions of pressure, temperature, etc.

**manometer pressure**—The excess of pressure inside the envelope of an aerostat over the atmospheric pressure at a standard reference point. The point of reference for the excess of pressure is usually the bottom of the envelope or gas cell for airships and the level of the basket for kite balloons.

**nominal gas capacity**—The volume of the envelope of gas cells of an aerostat under certain conditions of pressure and inflation which have been defined. It is rarely the same as the true full volume. This is usually very difficult to determine accurately, especially in the case of rigid airships. Sometimes called "volume."

**permeability**—The measure of the rate of diffusion of gas through intact balloon fabric; usually expressed in liters of hydrogen per square meter of fabric per 24 hours, under standard conditions of pressure and temperature.

**pressure height**—The altitude at which the gas cells of a rigid airship are full, or the gas bag of a nonrigid airship is completely full of gas.

**purity (of gas)**—The ratio of the pressure of the hydrogen (or other aerostatic gas) in the container to the total pressure due to all the contained gases.

## D. TERMS RELATING TO AEROSTATS—Continued

## (d) MISCELLANEOUS TERMS—Continued

**static ceiling**—The altitude in standard atmosphere, at which an aerostat is in static equilibrium after removal of all discharged weights.

**volume**—The volume of the air displaced by the gas used for inflation.

**useful lift**—The lift available for carrying fuel, and oil, passengers, cargo, food, and drinking water, guns, ammunition, and bombs. Usually determined by deducting from the gross lift all fixed weights; certain allowances of ballast, fuel, and oil; water; spares and tools; crew and equipment. No standard has as yet been established.

## E. TYPES OF AIRPLANES

**amphibian**—An airplane designed to rise from and alight on either land or water.

**biplane**—An airplane with two main supporting surfaces placed one above another. (Fig. 1.)

**flying boat**—A form of seaplane supported, when resting on the surface of the water, by a hull or hulls providing flotation in addition to serving as fuselages. (Fig. 9.) For the central hull type, lateral stability is usually provided by wing-tip floats. The term "boat seaplane" is now obsolete.

**landplane**—An airplane designed to rise from and alight on the land. (Figs. 1, 6, and 14.)

**monoplane**—An airplane which has but one main supporting surface, sometimes divided into two parts by the fuselage. (Fig. 6.)

**multiplane**—An airplane with two or more main supporting surfaces placed one above another.

**pusher airplane**—An airplane with the propeller or propellers in the rear of the main supporting surfaces. (Figs 9 and 14.)

**quadruplane**—An airplane with four main supporting surfaces, placed one above another.

**seaplane**—Any airplane designed to rise from and alight on the water. This general term applies to both boat and float types, though the boat type is usually designated as a "flying boat." (Figs. 9 and 10.)

**shipplane**—A landplane designed to rise from and alight on the deck of a ship.

**tandem airplane**—An airplane with two or more sets of wings of substantially the same area (not including the tail unit) placed one in front of the other and on about the same level.

**tractor airplane**—An airplane with the propeller or propellers forward of the main supporting surfaces. (Figs 1, 6, and 10.)

**triplane**—An airplane with three main supporting surfaces, placed one above another.

## F. TERMS RELATING TO AIRPLANES

## (a) OPERATION AND MANEUVERS

**bank**—To incline an airplane laterally, i. e., to rotate it about its longitudinal axis. Right-bank is to incline the airplane with the right wing down.

Also used as a noun to describe the position of an airplane when its lateral axis is inclined to the horizontal.

**ceiling:**

**absolute**—The maximum height above sea level at which a given airplane would be able to maintain horizontal flight, assuming standard air conditions.

**service**—The height above sea level, assuming standard air conditions, at which a given airplane ceases to be able to rise at a rate higher than a small specified one (100 feet per minute in the United States and England). This specified rate may be different in different countries.

**dive**—A steep descent, with or without power, in which the air speed is greater than the maximum speed in horizontal flight.

**glide**—A descent with reference to the air at a normal angle of attack and without engine power sufficient for level flight in still air, the propeller thrust being replaced by a component of gravity along the line of flight. Also used as verb.

## F. TERMS RELATING TO AIRPLANES—Continued

## (a) OPERATION AND MANEUVERS—Continued

**nose-heavy**—The condition of an airplane in normal flight when the distribution of forces is such that, if the longitudinal controls were released, the nose would drop.

**pancake, to**—To level off an airplane at a greater altitude than normal in a landing, thus causing it to stall and to descend on a steeply inclined path with the wings at a very large angle of attack and without appreciable bank.

**power loading**—The gross weight of an airplane, fully loaded, divided by the normal brake horsepower of the engine computed for air of standard density, unless otherwise stated

**range:**

**at economic speed**—The maximum distance a given aircraft can cover while cruising at the most economical speed and altitude at all stages of the flight.

**at full speed**—The maximum distance a given aircraft can cover at full speed at sea level.

**reverse turn**—A rapid maneuver to reverse the direction of flight of an airplane, made by a half loop and half roll.

**roll**—A maneuver in which a complete revolution about the longitudinal axis is made, the horizontal direction of flight being approximately maintained.

**side slipping**—Flight in which the lateral axis is inclined and the airplane has a component of velocity in the direction of the lower end of the lateral axis. When it occurs in connection with a turn, it is the opposite of skidding (q. v.).

**skidding**—Sliding sidewise away from the center of curvature when turning. It is usually caused by banking insufficiently, and is the opposite of side slipping (q. v.).

**sky writing**—The act of emitting from an aircraft a trail of smoke or other visible substance, the flight of the aircraft being so directed as to cause the trail to assume the form of letters or symbols.

**soar**—To perform sustained free flight without self-propulsion; it is called "up-current soaring" if performed in ascending air; "dynamic soaring" in other cases.

**speed:**

**critical**—The lowest speed of an aircraft at which control can be maintained.

**economic**—The speed at which the fuel consumption per unit of distance covered in still air is a minimum.

**landing**—The minimum speed at which an airplane can maintain itself in level flight and still be under adequate control.

**minimum**—The lowest steady speed which can be maintained by an airplane in level flight at an altitude large in comparison with the dimensions of the wings, with any throttle setting whatever.

**spin**—A maneuver consisting of a combination of roll and yaw, with the longitudinal axis of the airplane inclined steeply downward. The airplane descends in a helix of large pitch and very small radius, the upper side of the airplane being on the inside of the helix, and the angle of attack on the inner wing being maintained at an extremely large value.

**spiral**—A maneuver in which an airplane descends in a helix of small pitch and large radius, the angle of attack being within the normal range of flight angles.

**stall**—The condition of an airplane when from any cause it has lost the air speed necessary for support or control.

**tail-heavy**—In a heavier-than-air craft the condition in which in normal flight, the tail sinks if the longitudinal control is released, i. e., the condition in which the pilot has to exert a push on the control stick to keep the given attitude.

**tail slide**—The backward and downward motion, tail first, which certain airplanes may be made to take momentarily after having been brought into a stalling position by a steep climb.

**taxi**—To run an airplane over the ground or a seaplane on the surface of water under its own power.

## F. TERMS RELATING TO AIRPLANES—Continued

## (a) OPERATION AND MANEUVERS—Continued

- warp**—To change the form of a wing by twisting it. Warping is sometimes used to maintain the lateral equilibrium of an airplane.
- wing-heavy**—The condition of an airplane in which (in normal flight) there is a tendency for the right (or left) wing to drop, if the lateral control is released, i. e., the condition in which the pilot has to exert a lateral force on the control stick to keep the lateral axis horizontal.
- zoom**—To climb for a short time at an angle greater than that which can be maintained in steady flight, the airplane being carried upward at the expense of its kinetic energy. This term is sometimes used as a noun to denote any sudden increase in the upward slope of the flight path.

## (b) WING PARTS

- aileron**—A hinged or pivoted movable auxiliary surface of an airplane, usually part of the trailing edge of a wing, the primary function of which is to impress a rolling moment on the airplane. (Fig. 1.)
- antidrag wire**—A wire designed primarily to resist forces acting parallel to the chord of the wing of an airplane and in the same direction as the direction of flight. It is generally inclosed in the wing. (Fig. 1.)
- cabane**—A framework for supporting the wings at the fuselage; also applied to the system of trussing used to support overhang in a wing. (Figs. 6, 9, and 10.)
- drag strut**—A fore-and-aft compression member of the internal bracing system of a wing. (Figs. 1 and 15.)
- drag wire**—Any wire or cable designed primarily to resist drag forces.
- internal**—A drag wire concealed inside the wing. (Fig. 1.)
- external**—A drag wire run from a wing to the fuselage or other part of the airplane. (Fig. 1.)
- king-post**—The main compression member of a trussing system applied to support a single member subject to bending. (Figs. 4 and 6.)
- landing wire**—A wire designed primarily to resist forces in the opposite direction to the normal direction of the lift and to oppose the lift wire and prevent distortion of the structure by an overtightening of those members. (Fig. 1.) Sometimes called "antilift" wire.
- lift wire**—A wire or cable which transmits the lift on the outer portion of the wing of an airplane in toward the fuselage, or nacelle. This wire usually runs from the top of an interplane strut to the bottom of the strut next nearer the fuselage. Sometimes called "flying wire." (Fig. 1.)
- main supporting surface**—A set of wings, extending on the same general level from tip to tip of an airplane; e. g., a triplane has three main supporting surfaces. The main supporting surfaces include the ailerons, but no other surfaces intended primarily for control or stabilizing purposes.
- panel**—Where a wing surface comprises several units of construction, these units are designated as panels.
- skid fin**—A fore-and-aft vertical surface, usually placed above the upper wing, designed to provide vertical keel surface and so to increase lateral stability. (Figs. 9 and 10.)
- stagger wire**—A wire connecting the upper and lower surfaces of an airplane and lying in a plane substantially parallel to the plane of symmetry. (Also called "incidence wire.") (Fig. 1.)
- wing**—A general term applied to a whole or a portion of the main supporting surfaces of an airplane but in the latter case is usually qualified as right wing, left wing, upper wing, or lower wing, etc.

## F. TERMS RELATING TO AIRPLANES—Continued

## (b) WING PARTS—Continued

- wing rib**—A fore-and-aft member of the wing structure of an airplane, used to give the wing section its form and to transmit the load from the fabric to the spars. (Figs. 1 and 15.)
- compression rib**—A heavy rib designed to have the function of a wing rib and also to act as a strut opposing the pull of the wires in the internal drag truss. (Also called "drag strut.") (Figs. 1 and 15.)
- former or false rib**—An incomplete rib, frequently consisting only of a strip of wood extending from the leading edge to the front spar, which is used to assist in maintaining the form of the wing where the curvature of the airfoil section is sharpest. (Figs. 1 and 15.)
- wing spar**—The principal transverse structural member of the wing assembly of an airplane. (Figs. 1 and 15.)
- wing truss**—The framing by which the wing loads of an airplane are transmitted to the fuselage. It comprises struts, wires, cables, tie rods, and spars.

## (c) BODY PARTS

- bay**—The portion of a face of a truss, or of a fuselage, between adjacent bulkheads or adjacent struts or frame positions.
- body**—The fuselage or hull, or nacelle (including cowling and covering) and nacelle mounting. (Figs. 1, 6, 9, 10, and 14.)
- cockpit**—The open spaces in which the pilot and passengers are accommodated. (Fig. 1.) When the cockpit is completely housed in, it is called a cabin. (Figs. 1, 6, 9, 10, and 14.)
- control stick**—The vertical lever by means of which the longitudinal and lateral controls of an airplane are operated. Pitching is controlled by a fore-and-aft movement of the stick, rolling by a side-to-side movement. (Fig. 1.)
- cowling**—A removable covering which extends over or around the engine and sometimes over a portion of the fuselage or nacelle as well. (Figs. 1, 6, 10, and 14.)
- fire wall**—A fire-resistance transverse bulkhead, so set as to isolate the engine compartment from the other parts of the structure and thus to reduce the risk from fire in the engine compartment. (Fig. 1.)
- fuselage**—The structure, of approximately stream line form, to which are attached the wings and tail unit of an airplane. In general it contains the power plant, passengers, cargo, etc. (Figs. 1, 6, and 10.)
- longeron**—A fore-and-aft member of the framing of an airplane fuselage or nacelle, usually continuous across a number of points of support. (Fig. 1.)
- monocoque fuselage**—A type of fuselage construction wherein the structure consists of a thin shell of wood, metal, or other material, supported by ribs, frames, belt frames, or bulkheads, but usually without longitudinal members other than the shell itself. The whole is so disposed as to carry the stresses to which the structure is subjected. (Fig. 6.)
- nacelle**—An inclosed shelter for passengers or for a power plant. A nacelle is usually shorter than a fuselage, and does not carry the tail unit. (Fig. 14.)
- rudder**—A movable auxiliary airfoil, the function of which is to impress a yawing movement on the aircraft in normal flight. It is usually located at the rear of an aircraft. (Figs. 1, 9, 10, and 14.)
- tail boom**—A spar or outrigger connecting the tail surfaces and main supporting surfaces. (Fig. 14.)

## (d) LANDING GEAR PARTS

- float**—A completely inclosed water-tight structure attached to an aircraft in order to give it buoyancy and stability when in contact with the surface of the water. In float seaplanes the crew is carried in a fuselage or nacelle separate from the float. (Fig. 10.) The term "pontoon" is now obsolete.

## F. TERMS RELATING TO AIRPLANES—Continued

## (d) LANDING GEAR PARTS—Continued

- flotation gear**—An emergency gear attached to a landplane to permit alighting on the water and to provide buoyancy when resting on the surface of the water.
- hull**—The portion of a flying boat which furnishes buoyancy when in contact with the surface of the water. It contains accommodations for the crew and passengers, usually incorporating the functions of a float and fuselage in one unit. (Fig. 9.)
- landing gear**—The understructure which supports the weight of an aircraft when in contact with the surface of the land or water and reduces the shock on landing. There are five common types—boat type, float type, skid type, wheel type, and ski type. (Figs. 1, 6, 9, 10, and 14.) (Amphibian may be a combination of the float or boat type with wheels or skis.)
- shock absorber**—A device incorporated in the landing gear of an aircraft to reduce the shock imposed on the structure when alighting or taking off.
- Shock absorbing devices are usually interposed between the main structure and the wheels, floats, skis, or tail skids, to secure resiliency in landing and taxiing. (Fig. 1.)
- skid**—A runner used as a member of the landing gear and designed to aid the aircraft in landing or taxiing.
- tail skid**—A skid used to support the tail when in contact with the ground. (Figs 1, 6, and 14.)
- wing skid**—A skid placed near the wing tip and designed to protect the wing from contact with the ground. (Fig. 1.)
- step**—A break in the form of the bottom of a float or hull, designed to reduce resistance when under way by rapidly reducing the wetted surfaces as speed increases. It also serves to eliminate suction effects.

## (e) DIMENSIONS AND CHARACTERISTICS

- angle of stabilizer setting**—The acute angle between the line of thrust of an airplane and the chord of the stabilizer. (Fig. 1.)
- angle of wing setting**—The acute angle between the plane of wing chord and the line of thrust. It may differ for each wing. (Fig. 1.)
- decalage**—The acute angle between the wing chords of a biplane or multiplane. (Fig. 1.)
- gap**—The distance between the planes of the chords of any two adjacent wings, measured along a line perpendicular to the chord of the upper wing at any designated point of its leading edge. (Fig. 1.) Its symbol is  $G$ .
- landing angle**—The acute angle between the line of thrust of an airplane and the horizontal when the airplane is resting on level ground in its natural position. Also called "ground angle." (Fig. 1.)
- longitudinal dihedral angle**—The difference in angle of wing setting and of stabilizer setting. (Fig. 1.) This angle is positive when the angle of stabilizer setting, referred to the thrust line, is less than the angle of wing setting.
- mean chord of a combination of wings**—The ratio

$$\frac{c_1 S_1 + c_2 S_2 + c_3 S_3 + \dots}{S_1 + S_2 + S_3 + \dots}$$

where  $c_1, c_2, c_3$ , etc., are the mean chords of various wings, and  $S_1, S_2, S_3$ , etc., are their areas.

- mean chord of a wing**—The quotient obtained by dividing the wing area by the extreme dimension of the wing projection at right angles to the chord.
- over-all length**—The distance from the extreme front to the extreme rear of an aircraft, including the propeller and the tail unit.

## F. TERMS RELATING TO AIRPLANES—Continued

## (e) DIMENSIONS AND CHARACTERISTICS—Continued

- overhang**—Used in two senses. (1) One-half of the difference in span of any two main supporting surfaces of an airplane. The overhang is positive when the upper of the two main supporting surfaces has the larger span. (Fig. 1.) (2) The distance from the outer strut attachment to the tip of the wings.
- span**—The maximum distance measured parallel to the lateral axis from tip to tip of an airplane inclusive of ailerons. (Fig. 1.)
- stagger**—The amount of advance of the leading edge of an upper wing of a biplane, triplane, or multiplane over that of a lower, expressed either as a percentage of gap or in degrees of the angle whose tangent is the percentage just referred to. It is considered positive when the upper wing is forward and is measured from the leading edge of the upper wing along its chord to the point of intersection of this chord with a line drawn perpendicular to the chord of the upper wing at the leading edge of the lower wing, all lines being drawn in a plane parallel to the plane of symmetry. (Fig. 1.)
- sweep back**—The acute angle between the lateral axis of an airplane and the projection of the axis of the wing on the plane which includes the lateral and longitudinal axes. (Fig. 1.) (The axis of a wing is a line through the centroids of the sections of the wing.)
- washin**—Permanent warping of the wing which results in an increase in the angle of attack near the tip.
- washout**—Permanent warping of a wing which results in a decrease in the angle of attack near the tip.
- wing-dihedral or dihedral angle**—The acute angle between the transverse reference line in the wing surface and the lateral axis of the airplane projected on a plane perpendicular to the longitudinal axis. The dihedral angle is positive when the upper obtuse angle for the two wings is less than  $180^\circ$ . (Fig. 1.)
- wing loading**—The gross weight of an airplane, fully loaded, divided by the area of the supporting surface. The area used in computing the wing loading should include ailerons but not the stabilizer or elevators.

## G. TERMS COMMON TO AEROSTATS AND AIRPLANES

## (a) PARTS

- balanced surface**—A control surface which extends on both sides of the axis of the hinge or pivot in such a manner as to reduce the moment of the air forces about the hinge. (Figs. 1, 3, 4, and 5.)
- controls**—A general term applied to the means provided to enable the pilot to control the speed, direction of flight, attitude, and power of an aircraft.
- air controls**—The means employed to operate the control surfaces of the aircraft.
- engine controls**—The means employed to control the power output of the engines. (Control of speed may be effected by the air controls or the engine controls independently, or by either in conjunction with the other.)
- control stick**—The vertical level by means of which the longitudinal and lateral controls of an airplane are operated. Pitching is controlled by a fore-and-aft movement of the sticks, rolling by a side-to-side movement. (Fig. 1.)
- control surface**—A movable airfoil designed to be rotated or otherwise moved by the pilot in order to change the attitude of the airplane or airship.
- elevator**—A movable auxiliary airfoil, the function of which is to impress a pitching moment on the aircraft. The elevator is usually hinged to the stabilizer. (Figs. 1, 3, 4, 5, 6, 9, 10, 13, and 14.)
- fin**—A fixed surface, attached to a part of the aircraft, parallel to the longitudinal axis, in order to secure stability; for example, tail fin, skid fin, etc. Fins are sometimes adjustable. (Figs. 1, 3, 4, 5, 6, 9, 10, 13, and 14.)

## G. TERMS COMMON TO AEROSTATS AND AIRPLANES—Continued

## (a) PARTS—Continued

- fixed fuel tank**—A fuel tank which is not intended or fitted to be dropped, as "slip" tanks are.
- horn**—A short lever attached to a control surface of an aircraft; for example, aileron horn, rudder horn, elevator horn. (Figs. 1, 3, 9, 10, 13, and 14.)
- inspection window**—A small transparent window fitted in the envelope of a balloon or airship, or in the wing of an airplane, to allow inspection of the interior. (Figs. 1 and 3.)
- rigger**—One who is employed in assembling and aligning aircraft.
- rigging**—The assembling, adjusting, and aligning of the parts of an airplane, or the attachment and adjustment of the car, rudders, valves, controls, etc., of an airship.
- service tank**—A fixed fuel tank near each power unit, into which fuel from other tanks is pumped and from which the fuel supplying the engines is drawn.
- slip-fuel tank**—A fuel tank which is provided with a device permitting the quick dropping of the tank and contents as a whole in case of an emergency. Fitted on both airships and airplanes.
- stabilizer**—A normally fixed airfoil whose function is to lessen the pitching motion. It is usually located at the rear of an aircraft and is approximately parallel to the plane of the longitudinal and lateral axes. Also called "tail plane." In aerostats—same as "fin." The lobes of a kite balloon are sometimes referred to as stabilizers. (Figs. 1, 2, 3, 4, 5, 6, 9, 10, 13, and 14.)
- tail group (or tail unit)**—The stabilizing and control surfaces at the rear end of an aircraft, including stabilizer, fin, rudder, and elevator. (Also called "empennage.")

## (b) PERFORMANCE AND CONDITIONS OF FLIGHT

- air speed**—The speed of an aircraft relative to the air. Its symbol is  $V$ .
- controllability**—The quality in an airplane which makes it possible for the pilot to change its attitude easily and with the exertion of but little force.
- drift**—The lateral velocity of an aircraft due to air currents.
- drift angle**—The horizontal angle between the longitudinal axis of an aircraft and its path relative to the ground.
- dynamic factor**—The ratio between the load carried by any part of an aircraft when accelerating and the corresponding basic load.
- endurance**—The maximum length of time an aircraft can remain in the air at a given speed and altitude.
- factor of safety**—The ratio of the ultimate strength of a member to the maximum probable load in that member in actual use.
- flight path**—The path of the center of gravity of an aircraft with reference to the earth.
- ground speed**—The horizontal component of the velocity of an aircraft relative to the earth.
- load:**
- dead**—See WEIGHT EMPTY.
  - full**—Weight empty plus useful load. Also called "gross weight."
  - pay**—That part of the useful load from which revenue is derived, viz., passengers and freight.
  - useful**—The crew and passengers, oil and fuel, ballast other than emergency, ordnance, and portable equipment.
- load factor**—The ratio of any specified load on a member to the corresponding basic load. Generally applied to the ratio of the breaking load to a basic load.
- maneuverability**—That quality in an aircraft which makes it possible for the pilot to change its attitude rapidly.
- performance testing**—The process of determining performance characteristics.
- rate of climb**—The vertical component of the air speed of an aircraft, i. e., its vertical velocity with reference to the air.

## G. TERMS COMMON TO AEROSTATS AND AIRPLANES—Continued

## (b) PERFORMANCE AND CONDITIONS OF FLIGHT—Continued

- relative wind**—The motion of the air with reference to a body, i. e., its motions as observed by a man at rest on the body. The direction and velocity of the relative wind, therefore, are found by adding two vectors, one being the velocity of the air with reference to the earth, the other being equal and opposite to the velocity of the body with reference to the earth.
- wash**—The disturbance in the air produced by the passage of an airfoil. Also called the "wake" in the general case for any solid body.
- weight empty**—The structure, power plant, and fixed equipment of an aircraft. Included in this fixed equipment are the water in the radiator and cooling system, all essential instruments and furnishings, fixed electric wiring for lighting, heating, etc. In the case of the aerostat, the amount of ballast which must be carried to assist in making a safe landing must also be included.

## H. MATERIALS AND STRUCTURE

- balloon fabric**—The finished material, usually rubberized of which balloon or airship envelopes are made.
- biased**—Plied fabric in which the threads of the plies are at an angle to each other.
- parallel**—Plied fabric in which the threads of the plies are parallel to each other.
- cloth**—Fabric delivered by the bleachery or finisher before it has been proofed, doped, or specially treated for aeronautic use.
- dope (airplane)**—The liquid material applied to the cloth surfaces of airplanes to increase strength to produce tautness by shrinking, and to act as a filler for maintaining air-tightness.
- dope (airship)**—The liquid material applied to rubberized airship fabric to increase gas-tightness. In contrast with airplane dope, it does not cause shrinking.
- dope (pigmented)**—An aircraft dope to which a pigment has been added to make an opaque finish, or to protect it from the effects of sunlight.
- duralumin**—An alloy of aluminum which is much used in aeronautics, especially for the structure of airships and airplanes. Its chemical composition and physical properties are about as follows:
- Copper, 3.5 to 4.5 per cent.
  - Manganese, 0.4 to 1 per cent.
  - Magnesium, 0.2 to 0.75 per cent.
  - Aluminum, 92 per cent, minimum.
  - Tensile strength, ultimate, 55,000 pounds per square inch.
  - Tensile strength at elastic limit, 30,000 pounds per square inch.
  - Elongation of 2 inches at ultimate strength (test specimen  $\frac{1}{2}$  inch wide), 18 per cent.
  - Specific gravity not more than 2.85.
- fairing**—An auxiliary member or structure whose primary function is to reduce head resistance or drag of the part to which it is fitted (without, in general, contributing strength).
- fitting**—A generic term for any small part used in the structure of an airplane or airship. If without qualification, a metal part is usually understood. It may refer to other parts, such as "fabric fittings."
- gas-cell fabric**—The fabric used in gas cells of rigid airships, usually goldbeater's-skin fabric, q. v.
- goldbeater's-skin fabric**—A gas-containing fabric consisting of a layer of light, fine, strong cloth, usually cotton, to which one or more layers of goldbeater's skins have been cemented. The skins are on the inside and are usually further protected by a coat of fine varnish. Usually used in the gas cells of rigid airships.
- laminated wood**—A product formed by gluing or otherwise fastening together a number of laminations of wood with the grain substantially parallel. (Differs from plywood in that in the latter the grain of alternate plies is usually crossed at right angles; also, the plies of the latter are usually made up of veneer.)

**H. MATERIALS AND STRUCTURE—Continued**

**panel (aerostat)**—The unit piece of fabric of which the envelope or outer cover of an aerostat is made. Panels may be assembled into sections, gores, or rings, according to the method of manufacture followed.

In rigid airships the area bounded by two adjacent longitudinals and two adjacent transverses is often referred to as a "panel." This is a structural panel and the expression is borrowed from structural engineers.

**plywood**—A product formed by gluing together two or more layers of veneer. The alternate plies are usually placed with grain at right angles to the adjacent plies.

**proofing**—Material incorporated in the fabric of an aerostat at the time of manufacture, to increase its resistance to the weather and/or to prevent the passage of gas (or decrease its permeability).

**stay**—A wire or other tension member; for example, the stays of the wing and body trussing. (Fig. 1.)

**strut**—A compression member of a truss frame. For instance, the vertical members of the wing truss of a biplane (interplane struts) and the short vertical and horizontal members separating the longerons (q. v.) in the fuselage. (Fig. 1.)

**veneer**—Thin sheets of wood, either sliced with a knife or sawed.

**wire**—In aeronautics, refers specifically to drawn solid wire.

**I. AIRPORT AND LANDING FIELD TERMS**

**airport**—A locality, either of water or land, which is adapted for the landing and taking off of aircraft and which provides facilities for shelter, supply, and repair of aircraft; or a place used regularly for receiving or discharging passengers or cargo by air.

**airship station**—The complete assembly of sheds, masts, gas plants, shops, landing fields and related equipment required to operate airships and supply their needs. A station may include all or a part of the items enumerated. The base from which air ships are operated.

**apron**—A hard surface area of considerable extent immediately in front of the entrance of a hangar or aircraft shelter which is used for the handling of aircraft or for repair in clear weather.

**balloon bed**—A mooring place on the ground for a captive balloon.

**dock**—A term sometimes applied to an airship shed.

**docking rail**—A rail or a guide, constructed on the landing field and extending into the shed which supplies a means for holding the lateral pull of an airship's docking or handling lines. The pull is transmitted to the rails from wheeled cars or trolleys which are fitted on or in the rails. Usually two rails are fitted at the greatest distance apart which will permit them to be run into the shed.

**docking trolley**—A car or trolley fitted on (or in) docking rails to transmit the pull of an airship docking line. It is fitted with wheels having antifriction bearings so it can move freely in the rail. Usually some sort of quick-release device for letting go the line is also fitted.

**emergency landing field**—A locality, either of water or land, which is adapted for the landing and taking off of aircraft, but which is not equipped with facilities for shelter, supply, and repair of aircraft and is not used regularly for the receipt or discharge of passengers or cargo by air.

**ground cloth**—Canvas placed beneath an aerostat for its protection during inflation and deflation.

**ground gear**—The gear, or equipment, necessary for the landing and handling of an airship on the ground.

**hangar**—A shelter for housing aircraft. More properly applied to heavier-than-air craft.

**landing crew**—A detail of men necessary for the landing and handling of an airship on the ground. A "ground crew."

**landing field**—A field of such a size and nature as to permit of aircraft landing and taking off in safety. It may or may not be part of an airport or air station.

## I. AIRPORT AND LANDING FIELD TERMS—Continued

- landing T**—A large symbol shaped like a capital T which is laid out on a landing field or on the top of a building to guide operators of aircraft in landing and taking off.
- mast main mooring line**—A line led from the main winch of a mooring mast through the mooring attachment at the top of the mast and carried out to a point on the ground well to leeward of the mast. The airship's main mooring line is attached to this line and the airship is hauled to the mast by means of the joined lines. Sometimes called "ground wire" (British).
- mast yaw line**—One of the lines led from a winch at the base of the mooring mast through snatch blocks and carried out to leeward of the mast. The airship's yaw lines are attached to these lines. The snatch blocks are fixed to anchorages selected so that the joined lines tend to keep the airship into the wind and prevent her overriding the mast. These lines are also sometimes called "mast yaw guys" or "mast bow-steadying lines."
- mooring drag**—A movable and/or variable weight suspended from the after part of an airship's structure while moored at a mast to aid in restraining the vertical and lateral motions of the stern of the airship.
- mooring mast**—A mast or tower at the top of which there is mounted a fitting, so that the bow of an airship may be secured. It is usually provided with a ladder or staircase and a platform at the top, so that crew and passengers may enter or leave the airship, and also with piping for the supply of fuel, gas, and water. Sometimes called "mooring tower."
- overhead suspension**—A line leading from the roof of an airship shed and arranged to sustain the whole or a part of the weight of the structure of an airship when it is docked.
- ram**—The combination of tubes and springs which is mounted in gimbals at the top of a mooring mast. It consists of an outer tube which carries the gimbal mounting and within which slides an inner tube. The upper end of the inner tube carries the hollow cone which receives the airship's mooring cone and which is fitted to revolve freely. The inner tube can slide down into the outer tube and compress heavy springs, thus easing the shock when the mooring is made.
- shed**—A shelter for housing airships.
- shore**—A structural member for supporting the structure of a rigid or semirigid airship during building or docking, used in conjunction with (or without) a cradle.
- snatch-block anchorage**—An anchorage set in the ground for a snatch block used with a yaw line from a mooring mast. The anchorages may be of concrete or timber and are usually arranged at equal intervals around the circumference of a circle whose center is the mast; may also be applied to any anchorage for a snatch block used in hauling down an airship or kite balloon.
- three-point mooring**—A system of mooring an airship. It consists primarily of three lines running from a mooring ring (or point) on the airship to three points on the ground. These points are usually at the vertices of an equilateral triangle. The lines may be secured to anchorages at the points or run over snatch blocks and to equalizing gear. The endeavor is to moor the airship in such a manner that the dynamic lift due to the relative wind shall keep the airship at a constant height from the ground. It may be considered as a substitute for a mooring mast, usually an emergency substitute.

## J. AERODYNAMIC TERMS

## (a) AXES, ANGLES, FORCES, ETC.

- aerodynamic volume (airship)**—The volume of the form which must be driven through the air. Same as "air-volume."
- aileron angle**—The angular displacement of an aileron from its neutral position. It is positive when the trailing edge of the aileron is below the neutral position.
- angle of attack**—The acute angle between the chord of an airfoil and its direction of motion relative to the air. (This definition may be extended to other bodies than airfoils.) Its symbol is  $\alpha$ .

## J. AERODYNAMIC TERMS—Continued

## (a) AXLES, ANGLES, FORCES, ETC.—Continued

**angle of pitch**—The acute angle between two planes defined as follows: One plane includes the lateral axis of the aircraft and the direction of the relative wind; the other plane includes the lateral axis and the longitudinal axis. (In normal flight the angle of pitch is, then, the angle between the longitudinal axis and the direction of the relative wind.) This angle is denoted by  $\theta$  and is positive when the nose of the aircraft has risen.

**angle of roll, or angle of bank**—The acute angle through which an aircraft must be rotated about its longitudinal axis in order to bring its lateral axis into a horizontal plane. This angle is denoted by  $\phi$  and is positive when the left wing is higher than the right.

**angle of yaw**—The acute angle between the direction of the relative wind and the plane of symmetry of an aircraft. This angle is denoted by  $\psi$  and is positive when the aircraft has turned to the right.

**attitude**—The position of an aircraft as determined by the inclination of its axes to some frame of reference. If not otherwise specified, this frame of reference is fixed to the earth.

**axes of an aircraft**—Three fixed lines of reference, usually centroidal and mutually perpendicular. The longitudinal axis in the plane of symmetry, usually parallel to the axis of the propeller is called the longitudinal axis; the axis perpendicular to this in the plane of symmetry is called the normal axis; and the third axis perpendicular to the other two is called the lateral axis. In mathematical discussions, the first of these axes, drawn from front to rear, is called the  $X$  axis; the second, drawn upward, the  $Z$  axis; and the third, running from right to left, the  $Y$  axis.

**basic load**—The load on an aircraft when it is at rest or in a condition of unaccelerated rectilinear flight (for purposes of stress analysis).

**critical angle**—An angle of attack at which the flow about an airfoil changes abruptly with corresponding abrupt changes in the lift and drag.

**cross-wind force**—The component perpendicular to the lift and to the drag of the total air force on an aircraft or any part thereof. Its symbol is  $C$  and its absolute coefficient  $C_c$  is defined by

$$C_c = \frac{C}{qS}$$

where  $q$  is the impact pressure ( $= \frac{1}{2} \rho V^2$ ) and  $S$  is the effective area of the surface upon which the air force acts.

**downwash angle**—The angle through which an air stream is deflected by any lifting surface of an airplane. It is measured in a plane parallel to the plane of symmetry, and is denoted by the symbol  $\epsilon$ .

**drag**—The component parallel to the relative wind of the total air force on an aircraft or airfoil. Its symbol is  $D$ .

The "absolute drag coefficient" is  $C_D$  as defined by the equation

$$C_D = \frac{D}{qS}$$

in which  $D$  is the drag,  $q$  is the impact pressure ( $= \frac{1}{2} \rho V^2$ ) and  $S$  is the effective area of the surface upon which the air force acts.

In the case of an airplane, that part of the drag due to the wings is called "wing drag"; that due to the rest of the airplane is called "structural drag" or "parasite resistance."

**induced**—That portion of the wing drag induced by, or resulting from, the generation of the lift.

**profile**—That portion of the wing drag which is due to friction and turbulence in the fluid and which would be absent in a nonviscous fluid.

## J. AERODYNAMIC TERMS—Continued

## (a) AXES, ANGLES, FORCES, ETC.—Continued

**dynamic lift**—The lift impressed on an aerostat by aerodynamic forces.

**dynamic load**—Any load due to accelerations of an aircraft, and therefore proportional to its mass.

**dynamic (or impact) pressure**—The product  $\frac{1}{2} \rho V^2$ , where  $\rho$  is the density of the air and  $V$  is the relative speed of the air. It is the quantity measured by most air-speed instruments. Its symbol is  $q$ .

**dynamic trim**—Trim (or trimming) due to dynamic conditions or their change.

**elevator angle**—The angular displacement of the elevator from its neutral position. It is positive when the trailing edge of the elevator is below the neutral position.

**lift**—That component of the total air force on an aircraft or airfoil which is perpendicular to the relative wind and in the plane of symmetry. It must be specified whether this applies to a complete aircraft or to parts thereof. In the case of an airship, this is often called "dynamic lift." Its symbol is  $L$ .

The "absolute lift coefficient" is  $C_L$  as defined by the equation

$$C_L = \frac{L}{qS}$$

in which  $L$  is the lift,  $q$  is the impact pressure ( $= \frac{1}{2} \rho V^2$ ) and  $S$  is the effective area of the surface upon which the air force acts.

**minimum gliding angle**—The acute angle between the horizontal and the most nearly horizontal path along which an airplane can descend steadily in still air when the propeller is giving no thrust.

**Reynolds Number**—A name given the fraction,  $\rho \frac{Vl}{\mu}$ , in which

$\rho$  is the density of the fluid;

$V$  is the relative velocity of the fluid;

$l$  is the linear dimension of the body;

$\mu$  is the coefficient of viscosity of the fluid.

**rudder angle**—The acute angle between the rudder and the plane of symmetry of the aircraft. It is positive when the trailing edge has moved to the left with reference to the normal position of the pilot.

**rudder torque**—The twisting moment exerted by the rudder on the fuselage. The product of the rudder area by the distance from its center of area to the axis of the fuselage may be used as a relative measure of rudder torque.

**skin friction**—The tangential component of the fluid force at a point on a surface.

**static lift (aerostat)**—The resultant upward force on an aerostat at rest obtained by multiplying the actual volume of the air displaced by the density of the air and subtracting the weight of the contained gas. (The volume of the air displaced, multiplied by the difference of density of the air and the contained gas.)

**static trim**—Trim (or trimming) due to static conditions or their change.

**zero-lift angle**—The angle of attack of an airfoil when its lift is zero.

**zero-lift line**—A line through the trailing edge of an airfoil section parallel to the direction of the wind when the lift is zero.

## (b) MISCELLANEOUS TERMS

**airfoil**—Any surface designed to be projected through the air in order to produce a useful dynamic reaction.

**airfoil section (or profile)**—A cross section of an airfoil made by a plane parallel to a specified reference plane. A line perpendicular to this plane is called the axis of the airfoil.

## J. AERODYNAMIC TERMS—Continued

## (b) MISCELLANEOUS TERMS—Continued

**aspect ratio**—The ratio of span to mean chord of an airfoil; i. e., the ratio of the square of the maximum span to the total area of an airfoil.

**camber**—The rise in the curve of an airfoil section from its chord, usually expressed as the ratio of the departure of the curve from the chord to the length of the chord. "Upper camber" refers to the upper surface of an airfoil and "lower camber" to the lower surface; "mean camber" is the mean of these two.

**center of pressure coefficient**—The ratio of the distance of the center of pressure from the leading edge to the chord length.

**center of pressure of an airfoil section**—The point in the chord of an airfoil section, prolonged if necessary, which is at the intersection of the chord and the line of action of the resultant air force. Its abbreviation is *C. P.*

**chord (of an airfoil section)**—The line of a straight edge brought into contact with the lower surface of the section at two points; in the case of an airfoil having double convex camber, the straight line joining the leading and trailing edges. (These edges may be defined, for this purpose, as the two points in the section which are farthest apart.) (Fig. 1.) The line joining the leading and trailing edges should be used also in those cases in which the lower surface is convex except for a short flat portion.

The method used for determining the chord should always be explicitly stated for those sections with regard to which ambiguity seems likely to arise.

**chord length**—The length of the projection of the airfoil section on its chord. Its symbol is *c*.

**leading edge**—The foremost edge of an airfoil or propeller blade. Also called "entering edge." (Fig. 1.)

**span (airfoil)**—The lateral dimension of an airfoil; i. e., its dimension perpendicular to its chord. Its symbol is *b*.

**streamline**—The path of a small portion of a fluid relative to a solid body with respect to which the fluid is moving. The term is commonly used only of such flows as are not eddying, but the distinction should be made clear by the context.

**streamline flow**—Steady flow past a solid body; i. e., a flow in which the direction at every point is independent of time.

**streamline form**—A solid body which produces approximately streamline flow.

**trailing edge**—The rearmost edge of an airfoil or propeller blade. (Fig. 1.)

**wind tunnel**—An elongated chamber, usually a tube divergent at the ends, through which a steady air stream may be drawn or forced. Models of airfoils, of aircraft, or of propellers may be placed in the middle portion of the tunnel, called the experiment chamber or working section, and supported by suitable balances placed outside the air stream, so that the forces, moments, etc., due to the moving air may be measured.

## (c) STABILITY THEORY

**damping factor**—The factor  $e^{-\lambda t}$  in the equation of damped harmonic motion

$$s = Ae^{-\lambda t} \sin pt.$$

**divergence**—A motion in which, after a disturbance from equilibrium, the body departs continuously, without oscillations, from its original state of motion.

**logarithmic decrement**—The natural logarithm of the ratio of two successive amplitudes in a damped harmonic motion. It is equal to the product  $\lambda T$  where  $\lambda$  is the coefficient appearing in the damping factor of damped harmonic motion and  $T$  is the period of the motion.

**period**—The time taken for a complete oscillation.

## J. AERODYNAMIC TERMS—Continued

## (c) STABILITY THEORY—Continued

- phugoid oscillation**—A long-period oscillation characteristic of the disturbed longitudinal motion of an aircraft. This is referred to when it is said that an aircraft "hunts."
- resistance derivatives**—Quantities expressing the variation of the forces and moments on aircraft due to disturbance of steady motion. They form the experimental basis of the theory of stability, and from them the periods and damping factors of aircraft can be calculated. In the general case, there are 18 translatory and 18 rotary derivatives.
- rotary**—Resistance derivatives expressing the variation of moments and forces due to small changes in the rotational velocities of the aircraft.
- translatory**—Resistance derivatives expressing the variation of moments and forces due to small changes in the translational velocities of the aircraft.
- righting moment (or restoring moment)**—A moment which tends to restore an aircraft to its previous attitude after any small rotational displacement.
- stability**—That property of a body which causes it, when disturbed from a condition of equilibrium or steady motion, to develop forces or moments which tend to restore the body to its original condition.
- automatic**—Stability dependent upon movable control surface automatically operated by mechanical means.
- inherent**—Stability of an aircraft due solely to the disposition and arrangement of its fixed parts; i. e., that property which causes it, when disturbed, to return to its normal attitude of flight without the use of controls or the interposition of any mechanical devices.
- static**—Stability of such a character that, if the airplane is displaced slightly from its normal attitude by rotation about an axis through its center of gravity (as may be done in wind-tunnel experiments), moments come into play which tend to return the airplane toward its original attitude.
- dynamic**—Stability of such a character that, if the airplane is displaced from steady motion in flight, it tends to return to that steady state of motion, the oscillations due to restoring moments being damped out.
- In a general way, the difference between static stability and dynamic stability is that the former depends on restoring moments alone, while the latter includes the action of damping factors.
- longitudinal**—Stability with reference to disturbances in the plane of symmetry; i. e., disturbances involving pitching and variation of the longitudinal and normal velocities.
- directional**—Stability with reference to rotations about the normal axis; i. e., an airplane possesses directional stability in its simplest form if a restoring moment comes into action when it is given a small angle of yaw. Owing to symmetry, directional stability is closely associated with lateral stability.
- lateral**—Stability with reference to disturbances involving rolling, yawing, or side slipping; i. e., disturbances in which the position of the plane of symmetry of the aircraft is affected.
- spiral instability**—A type of instability inherent in certain airplanes which becomes evident when the airplane, as a result of a yaw, assumes too great a bank and side slips; the bank continues to increase and the radius of the turn to decrease.
- stable oscillation**—An oscillation whose amplitude does not increase.
- unstable oscillation**—An oscillation whose amplitude increases continuously until an attitude is reached from which there is no tendency to return toward the original attitude, the motion becoming a steady divergence.

## K. PROPELLER TERMS

## (a) MISCELLANEOUS

**blade back**—The side of a propeller blade which corresponds to the upper surface of an airfoil.

**blade face**—The surface of a propeller blade which corresponds to the lower surface of an airfoil.

Sometimes called "thrust face" or "driving face."

**propeller:**

**adjustable pitch**—A propeller whose blades are so attached to the hub that they may be set to any desired pitch when the propeller is stationary.

**controllable pitch or variable pitch**—A propeller whose blades are so mounted that they may be turned about their axis to any desired pitch while the propeller is in rotation.

**propeller blade**—See blade back, blade face, blade width ratio. (Fig. 1.)

**propeller boss**—The central portion of a propeller in which the hub is formed or mounted. (Fig. 1.)

**propeller hub**—The metal fitting inserted or incorporated in or with a propeller for the purpose of mounting it on the propeller or engine shaft. (Fig. 1.)

**propeller root**—That part of the propeller blade near the boss. (Fig. 1.)

**pusher propeller**—A propeller mounted to the rear of the engine or propeller shaft. (It is usually behind the wing cell or nacelle.) (Figs. 9 and 14.)

**spinner**—A fairing of approximately conical or paraboloidal form, which is fitted coaxially with the propeller boss and revolves with the propeller. (Fig. 1.)

**tipping (propeller)**—A sheet metal (or equivalent) protective covering of the blade of a propeller near the tip, extended a short distance along the trailing edge and a considerable distance along the leading edge. (Fig. 1.)

**tractor propeller**—A propeller mounted on the forward end of the engine or propeller shaft. (It is usually forward of the fuselage or wing nacelle.) (Figs. 1, 6, and 10.)

## (b) AERODYNAMICAL

**angle of propeller blade**—The acute angle between the chord of a propeller section and a plane perpendicular to the axis of rotation of the propeller. Usually called "blade angle."

**aspect ratio of propeller blade**—Half the ratio of propeller diameter to maximum blade width.

**blade-width ratio**—The ratio of the developed width of a propeller blade at any point to the circumference of the circle whose radius is the distance of that point from the propeller axis.

**effective helix angle**—The angle of the helix described by a particular point on a propeller blade as the airplane moves forward through air otherwise undisturbed. It is equal to the angle whose tangent is the ratio of the velocity of flight to the product of the four quantities:  $2\pi$ ,  $r$  (the distance from the axis to the point in question) and  $n$  (the number of revolutions per second), i. e.

$$\Phi = \tan^{-1} \left( \frac{V}{2\pi rn} \right)$$

**effective thrust**—The net driving force delivered by a propeller when mounted on an airplane; i. e., the actual thrust given by the propeller as mounted on the airplane minus any increase of resistance of the airplane produced by the action of the propeller.

**indraft (inflow)**—The flow of air from in front of the propeller into the blades.

**pitch of a propeller:**

**effective**—The distance which an aircraft advances along its flight path for one revolution of the propeller. Its symbol is  $p_e$ .

**geometrical**—The distance which an element of a propeller would advance in one revolution, if it were moving along a helix of slope equal to its blade angle.

**mean geometrical**—The mean of the geometrical pitches of the several elements. Its symbol is  $p_g$ .

**standard**—The geometrical pitch taken at two-thirds of the radius. Also called "nominal pitch." Its symbol is  $p_s$ .

## K. PROPELLER TERMS—Continued

## (b) AERODYNAMICAL—Continued

**pitch of a propeller**—continued.

**zero thrust**—The distance which a propeller would have to advance in one revolution in order that there might be no thrust. Also called "experimental mean pitch." Its symbol is  $p_v$ .

**zero torque**—The distance which a propeller would have to advance in one revolution in order that the torque might be zero. Its symbol is  $p_a$ .

**pitch ratio**—The ratio of the pitch (geometrical, unless otherwise stated) to the diameter.  $p/D$ .

**pitch speed**—The product of the mean geometrical pitch by the number of revolutions of the propeller in unit time; i. e., the speed the aircraft would make, if there were no slip.

**propeller area, projected**—The total area in the plane perpendicular to the propeller shaft swept by the propeller, excepting the portion covered by the boss and that swept by the root of the blade. This portion is usually taken as extending 0.2 of the maximum radius from the axis of the shaft.

**propeller-blade area**—The area of the blade face, exclusive of the boss and the root, i. e., of a portion which is usually taken as extending 0.2 of the maximum radius from the axis of the shaft.

**propeller-camber ratio**—The ratio of the maximum thickness of a propeller section to its chord.

**propeller-disk area, total**—The total area swept by a propeller; i. e., the area of a circle having a diameter equal to the propeller diameter.

**propeller efficiency**—The ratio of thrust power to power input of a propeller. Its symbol is  $\eta$ .

**propeller interference**—The amount by which the torque and thrust of a propeller are changed by the modification of the air flow in the slip stream produced by bodies placed near the propeller such as engine, radiator, etc.

**propeller-load curve**—A curve representing the engine power necessary to drive any given propeller at various speeds. The power required varies approximately as the cube of the speed in R. P. M. provided the ratio  $\frac{V}{ND}$  remains constant.

**propeller rake**—The mean angle which the line joining the centroids of the sections of a propeller blade makes with a plane perpendicular to the axis.

**propeller section**—A cross section of a propeller blade made at any point by a plane parallel to the axis of rotation of the propeller and tangent at the centroid of the section to an arc drawn with the axis of rotation as its center.

**propeller thrust**—The component parallel to the propeller axis of the total air force on the propeller. Its symbol is  $T$ .

**propeller torque**—The moment applied to the propeller by the engine shaft. Its symbol is  $Q$ .

**propeller-width ratio, total**—The product of blade width ratio at the point of maximum blade width by number of blades.

**propulsive efficiency**—The ratio of the product of effective thrust and flight speed to the actual power input to the propeller as mounted on the airplane, consistent units being used throughout.

**race rotation**—The rotation, produced by the action of the propeller, of the stream of air passing through or influenced by the propeller.

**slip**—The difference between the mean geometrical pitch and the effective pitch. Slip may be expressed as a percentage of the mean geometrical pitch or as a linear dimension.

**slip function**—The ratio of speed of advance through the undisturbed air to the product of propeller diameter by the number of revolutions in unit time, i. e.,  $\frac{V}{ND}$ . The slip function is the primary factor controlling propeller performance. It is  $\pi$  times the ratio of forward speed to the tip speed of the propeller.

**slip stream**—The stream of air driven astern by the propeller. (The indraft is sometimes included also.)

**static thrust**—The thrust developed by a propeller when rotating at a fixed point.

## L. INSTRUMENTS AND AUXILIARY APPARATUS

**accelerometer**—An instrument for indicating, measuring, or recording accelerations.

**air log**—An instrument for measuring the linear travel of an aircraft relative to the air. One form consists of a windmill with a revolution counter.

**air-speed meter**:

**air-speed indicator**—An instrument for indicating the speed of an aircraft relative to the air. It is actuated by the pressure developed in a suitable pressure nozzle or against a suitable obstruction and is graduated to give true air speed at a standard air density. The speed indicated by the instrument is termed the "indicated air speed." (The indicated speed is a direct measure of the lift or drag exerted on the airplane at any altitude. Stalling at all altitudes occurs for the same value of the indicated speed.)

**true air-speed meter**—An instrument for measuring the true speed of an aircraft relative to the air. The Biram and Robinson anemometers are of this type.

**altigraph**—An altimeter equipped with recording mechanism. Present instruments are of the aneroid type. The chart, driven by clockwork, is usually graduated in feet or meters in accordance with some empirical or arbitrary pressure-temperature-altitude formula. In other words, it is a barograph whose scale is designed to read heights.

**altimeter**—An instrument for measuring or indicating the elevation of an aircraft above a given datum plane.

**anemometer**—An instrument for indicating or measuring the speed of an air stream.

**aneroid altimeter**—An altimeter, the indications of which depend on the deflection of a pressure-sensitive element. The graduations of the dial correspond to an empirical or arbitrary pressure-temperature-altitude formula.

**ballonet-fullness indicator**—An instrument for indicating the volume of air in a ballonet.

**barograph**—An instrument for recording the barometric or static pressure of the atmosphere.

**drift bar**—A part of a drift meter or other instrument for indicating the apparent direction of motion of the ground relative to the fore-and-aft axis of the aircraft. It usually consists of a wire or arm which can be set along this direction of motion. Cf. drift.

**drift meter**—An instrument for measuring the angle between the fore-and-aft axis of an aircraft and its path over the ground. One form consists of a drift bar provided with a suitable angular scale. Cf. drift. The instrument is graduated to read correctly when it is level.

**electrical-capacity altimeter**—An altimeter, the indications of which depend on the variation of an electrical capacity with distance from the earth's surface.

**engine altimeter**—An altimeter for indicating the altitude corresponding to the pressure produced in the intake manifold of a supercharged engine.

**flight indicator**—An instrument in which a lateral inclinometer, a fore-and-aft inclinometer, and a turn indicator are combined to form a compact unit.

**flight recorder**—An instrument for recording certain elements of the performance of an aircraft.

**gas-cell alarm**—A device, fitted adjacent to a gas cell, which indicates or warns when a predetermined limiting pressure has been reached in the gas cell. Also called "pressure alarm."

**ground-speed meter**—An instrument for measuring the speed of an aircraft relative to the ground. In present types of instruments some reference line in the instrument must first be set parallel to the apparent direction of motion of the aircraft with reference to the ground before the speed measurement is made. This is usually accomplished by the use of a drift meter, the adjustment of which automatically orients the ground-speed meter properly. Thus both the magnitude and direction of the motion of the aircraft with reference to the ground are obtained.

**gyroscopic turn indicator**—A turn indicator dependent on gyroscopic action.

**inclinometer**—An instrument for indicating the attitude of an aircraft. Inclinometers are termed fore-and-aft, lateral, or universal, according as they indicate inclination on the vertical plane through the fore-and-aft axis, or in the vertical plane through the lateral axis, or in both planes, respectively.

## L. INSTRUMENTS AND AUXILIARY APPARATUS—Continued

- induction compass**—A compass, the indications of which depend on the current generated in a coil revolving in the earth's magnetic field.
- absolute**—An instrument which indicates the attitude of an aircraft with reference to the vertical. The indications of instruments of this type usually depend on gyroscopic action.
- relative**—An instrument which indicates the attitude of an aircraft with reference to apparent gravity; i. e., to the resultant of the acceleration of the aircraft and that due to gravity.
- kymograph**—An instrument for recording the angular oscillations of an aircraft in flight with respect to axes fixed in space. The reference direction is usually given by a gyroscope or beam of sunlight.
- leak detector**—An instrument which detects the presence of hydrogen and other light gases in the air and which can be adapted to find leaks in a container inflated with such a gas.
- mechanical stabilizer**—A mechanical device to prevent an aircraft from departing from a condition of steady motion, or, in case such a motion is disturbed, to restore it to its steady state. Includes gyroscopic stabilizers, pendulum stabilizers, inertia stabilizers, etc.
- optical altimeter**—An altimeter, the indications of which depend on the manipulation of a suitable optical system.
- pitch indicator**—An instrument for indicating the existence of a pitching velocity of an aircraft. Cf. turn indicator.
- Pitot tube**—A cylindrical tube with an open end which is pointed upstream (i. e., so that the air meets the instrument head-on or is met head-on by the instrument). When the aircraft is flying less than about 200 miles per hour, the instrument measures the impact pressure. When used on aircraft, it is usually associated either with a closed coaxial tube surrounding it or with a closed tube placed near it and parallel to it, the combination being termed a Pitot-static tube. The associated tube has perforations in its side so that it is subjected to static pressure, as distinct from impact pressure. The speed of the fluid can be determined from the difference between the impact pressure and the static pressure, as read by a suitable gauge. (Fig. 7.) In common terminology, the Pitot-static combination, as above, is often termed simply a Pitot tube or Pitot.
- power Venturi**—A Venturi tube used to operate gyroscopic turn indicators and other instruments.
- pressure nozzle**—An instrument which, in combination with a gauge, is used to measure the indicated speed of an aircraft relative to the air. It may be a Pitot-static or a Venturi tube, or a combination of a Pitot tube and a Venturi tube.
- sound-ranging altimeter**—An altimeter, the indications of which depend on the measurement of the time required for a sound wave to travel from the aircraft to the earth and back.
- speed-indicating Venturi**—A Venturi tube may be combined with a Pitot tube or with a tube giving static pressure to form a pressure nozzle which may be used to determine the indicated speed of an aircraft through the air. The pressure difference is measured by a suitable gauge.
- static turn indicator**—A turn indicator actuated by the difference in pressure between static tubes mounted near the wing tips equidistant from the plane of symmetry and in a plane parallel to the lateral axis.
- statoscope**—An instrument for detecting minute changes of altitude of an aircraft. The indications of the instrument usually depend on small changes of the static pressure of the air.
- superheat meter**—An instrument for measuring the difference in temperature between the gas in a gas container of a lighter-than-air craft and the surrounding air.
- thermograph**—An instrument for recording temperature.
- turn indicator**—An instrument for indicating the existence of an angular velocity of turn of an aircraft about the normal axis. In horizontal flight it indicates the presence of a yawing velocity. "Turn meter" is the term applied to certain types.

## L. INSTRUMENTS AND AUXILIARY APPARATUS—Continued

- Venturi tube**—A short tube with flaring ends and a narrow or constricted section between them, into which a side tube opens. When fluid flows through the Venturi, there is a reduction of pressure in the constricted section, the amount of the reduction being a function of the velocity of flow. (Fig. 8.)
- vertimeter**—A device for indicating the rate of rise and fall of an aerostat, usually a special form of statoscope. A rate-of-climb meter serves the same purpose, although of a different form.
- water-recovery apparatus**—Apparatus carried on an airship for condensing and recovering the water contained in the exhaust gases of internal-combustion engines, in order to avoid the necessity of valving gas as the fuel is consumed.
- water-recovery condenser**—That part of the water-recovery apparatus which is devoted to the condensing of water in the exhaust gases. It may consist of a number of metal tubes or of a fabric box with appropriate inlets, outlets, and baffles.
- windmill**—An air-driven screw used to drive auxiliary apparatus on an aircraft.
- yawmeter**—An instrument for measuring the angle of yaw.

## M. ENGINE TERMS

## (a) TYPES OF ENGINES

- barrel-type engine**—An engine having its cylinders arranged equidistant from and parallel to the main shaft.
- inverted engine**—An engine having its cylinders below the crankshaft.
- left-hand engine**—An engine whose propeller shaft, to an observer facing the propeller from the antipropeller end of the shaft, rotates in a counterclockwise direction.
- left side (engine)**—That side which, to an observer looking from the antipropeller end toward the propeller end, lies on the left-hand side.
- radial engine**—An engine having stationary cylinders arranged radially around a common crankshaft.
- right-hand engine**—An engine whose propeller shaft, to an observer facing the propeller from the antipropeller end of the shaft, rotates in a clockwise direction.
- right side (engine)**—That side which, to an observer looking from the antipropeller end toward the propeller end, lies on the right-hand side.
- rotary engine**—An engine having revolving cylinders arranged radially around a common fixed crankshaft.
- supercharged engine**—An engine with mechanical means for increasing the cylinder charge beyond that normally taken in at the existing atmospheric pressure and temperature.
- vertical engine**—An engine having its cylinders arranged vertically above the crankshaft.
- V-type engine**—An engine having its cylinders arranged in two rows, forming, in the end view, the letter "V."
- W-type engine**—An engine having its cylinders arranged in three rows, forming, in the end view, the letter "W." Sometimes called the "broad-arrow type."

## (b) SUPERCHARGERS

- supercharger**—A mechanical device for supplying the engine with a greater weight of charge than would normally be induced at the prevailing atmospheric pressure and temperature.
- centrifugal type**—A supercharging device equipped with one or more rotating impellers generating centrifugal force which is utilized for the compression and the transmission of the air against resistance.
- positive-driven type**—A supercharger driven at a fixed speed ratio from the engine shaft by gears or other positive means.
- rotary-blower type**—A supercharging device comprising one or more relatively slow-speed rotors revolving in a stationary case in such a way as to provide a positive displacement.
- turbo type**—A supercharger driven by a turbine operated by the exhaust gases from the engine.

## M. ENGINE TERMS—Continued

## (c) MISCELLANEOUS TERMS

**brake mean effective pressure**—The net unit pressure which, if applied during the power strokes to the pistons of an engine having no mechanical losses, would produce the given brake horsepower at the stated speed.

**dry weight of an engine**—The weight of the engine, including carburetor and ignition systems complete, propeller hub assembly, reduction gears, if any, but excluding exhaust manifolds, oil and water. If the starter is built into the engine as an integral part of the structure, its weight shall be included.

**fixed power-plant weight for a given airplane**—The weight of the engine, including ignition, carburetor and induction systems complete, propeller and hub, exhaust manifolds, radiator and water, *if used*, with all interconnecting wires, controls, tanks, and pipes, lubricating oil temperature regulators, *the oil contained in the engine crank case*, and the starting gear attached to the engine, but excluding fuel, oil, and engine instruments.

**maximum horsepower of an engine**—The maximum horsepower which an engine can develop.

**maximum revolutions**—The number of revolutions per minute corresponding to the maximum horsepower.

**rated horsepower of an engine**—The average horsepower developed by an engine of a given type in passing the standard 50-hour endurance test.

**rated revolutions**—The number of revolutions corresponding to the rated horsepower.

**specific fuel (or oil) consumption**—The weight of fuel (or oil) consumed per brake horsepower-hour.

**weight per horsepower**—The dry weight of an engine divided by the rated horsepower.

# REPORT No. 240

## NOMENCLATURE FOR AERONAUTICS

BY THE NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS

### PART III

#### AERONAUTICAL SYMBOLS

##### 1. FUNDAMENTAL AND DERIVED UNITS

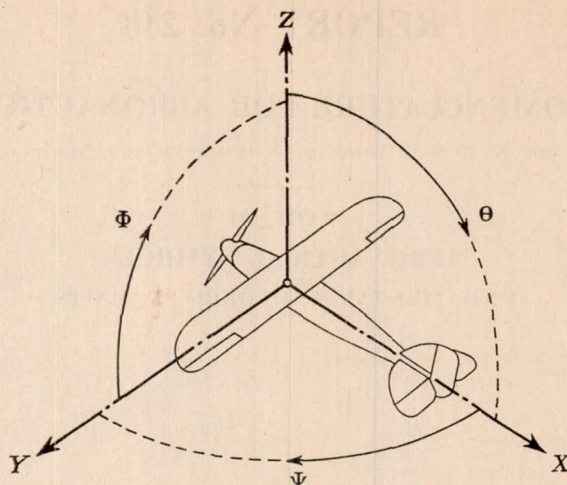
	Symbol	Metric		English	
		Unit	Symbol	Unit	Symbol
Length-----	$l$	meter-----	m	foot (or mile)-----	ft. (or mi.)
Time-----	$t$	second-----	sec	second (or hour)-----	sec. (or hr.)
Force-----	$F$	weight of one kilogram-----	kg	weight of one pound-----	lb.
Power-----	$P$	kg/m/sec-----		horsepower-----	HP.
Speed-----		km/hr-----		mi./hr-----	M. P. H.
		m/sec-----		ft./sec-----	f. p. s.

##### 2. GENERAL SYMBOLS, ETC.

$W$ , Weight, $=mg$	$mk^2$ , Moment of inertia (indicate axis of the radius of gyration, $k$ , by proper subscript).
$g$ , Standard acceleration of gravity = 9.80665 m/sec. <sup>2</sup> = 32.1740 ft./sec. <sup>2</sup>	
$m$ , Mass, $=\frac{W}{g}$	$S$ , Area.
$\rho$ , Density (mass per unit volume).	$S_w$ , Wing area, etc.
Standard density of dry air, 0.12497 (kg-m <sup>-4</sup> sec. <sup>2</sup> ) at 15° C and 760 mm = 0.002378 (lb.-ft. <sup>-4</sup> sec. <sup>2</sup> ).	$G$ , Gap.
Specific weight of "standard" air, 1.2255 kg/m <sup>3</sup> = 0.07651 lb./ft. <sup>3</sup>	$b$ , Span.
	$c$ , Chord length.
	$b/c$ , Aspect ratio.
	$f$ , Distance from $c. g.$ to elevator hinge.
	$\mu$ , Coefficient of viscosity.

##### 3. AERODYNAMICAL SYMBOLS

$V$ , True air speed.	$\gamma$ , Dihedral angle.
$q$ , Dynamic (or impact) pressure $=\frac{1}{2}\rho V^2$	$\frac{Vl}{\mu}$ , Reynolds Number, where $l$ is a linear dimension.
$L$ , Lift, absolute coefficient $C_L = \frac{L}{qS}$	e. g., for a model airfoil 3 in. chord, 100 mi./hr. normal pressure, 0° C: 255,000 and at 15° C., 230,000;
$D$ , Drag, absolute coefficient $C_D = \frac{D}{qS}$	or for a model of 10 cm chord 40 m/sec, corresponding numbers are 299,000 and 270,000.
$C$ , Cross-wind force, absolute coefficient $C_c = \frac{C}{qS}$	$C_p$ , Center of pressure coefficient (ratio of distance of $C. P.$ from leading edge to chord length.
$R$ , Resultant force. (Note that these coefficients are twice as large as the old coefficients $L_c, D_c$ .)	$\beta$ , Angle of stabilizer setting with reference to lower wing, $= (i_t - i_w)$ .
$i_w$ , Angle of setting of wings (relative to thrust line).	$\alpha$ , Angle of attack.
$i_t$ , Angle of stabilizer setting with reference to thrust line.	$\epsilon$ , Angle of downwash.



Positive directions of axes and angles (forces and moments) are shown by arrows

Axis		Force (parallel to axis) symbol	Moment about axis			Angle		Velocities	
Designation	Symbol		Designation	Symbol	Positive direction	Designation	Symbol	Linear (component along axis)	Angular
Longitudinal	X	X	rolling	L	Y → Z	roll	Φ	u	p
Lateral	Y	Y	pitching	M	Z → X	pitch	Θ	v	q
Normal	Z	Z	yawing	N	X → Y	yaw	Ψ	w	r

Absolute coefficients of moment

$$C_L = \frac{L}{q b S} \quad C_M = \frac{M}{q c S} \quad C_N = \frac{N}{q f S}$$

Angle of set of control surface (relative to neutral position),  $\delta$ . (Indicate surface by proper subscript.)

#### 4. PROPELLER SYMBOLS

$D$ , Diameter.  
 $p_e$ , Effective pitch  
 $p_g$ , Mean geometric pitch.  
 $p_s$ , Standard pitch.  
 $p_v$ , Zero thrust.  
 $p_a$ , Zero torque.  
 $p/D$ , Pitch ratio.  
 $V'$ , Inflow velocity.  
 $V_s$ , Slip stream velocity.

$T$ , Thrust.  
 $Q$ , Torque.  
 $P$ , Power.

(If "coefficients" are introduced all units used must be consistent.)

$\eta$ , Efficiency =  $T V / P$ .  
 $n$ , Revolutions per sec., r. p. s.  
 $N$ , Revolutions per minute., R. P. M.  
 $\Phi$ , Effective helix angle =  $\tan^{-1} \left( \frac{V}{2\pi r n} \right)$

#### 5. NUMERICAL RELATIONS

1 HP. = 76.04 kg/m/sec. = 550 lb./ft./sec.  
 1 kg/m/sec. = 0.01315 HP.  
 1 mi./hr. = 0.44704 m/sec.  
 1 m/sec. = 2.23693 mi./hr.

1 lb. = 0.4535924277 kg.  
 1 kg = 2.2046224 lb.  
 1 mi. = 1609.35 m = 5280 ft.  
 1 m = 3.2808333 ft.

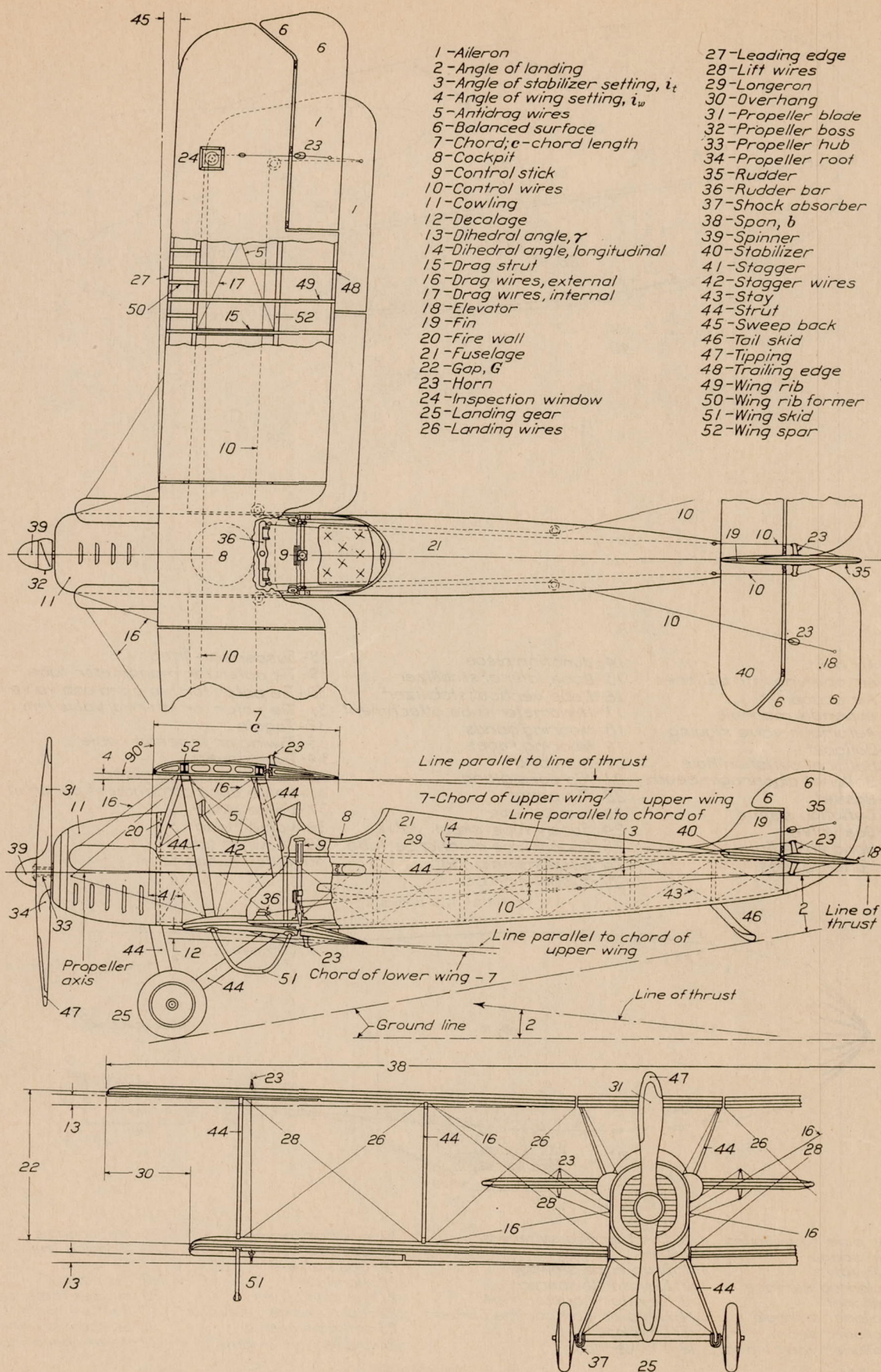
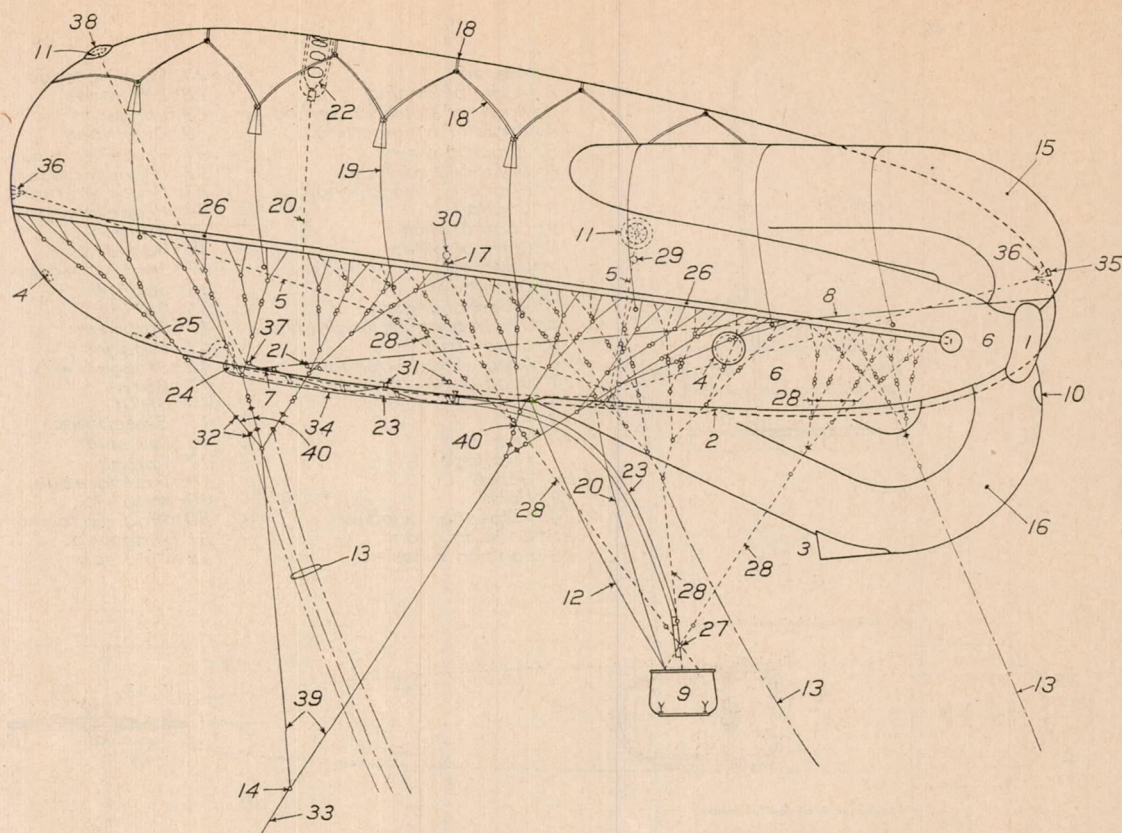
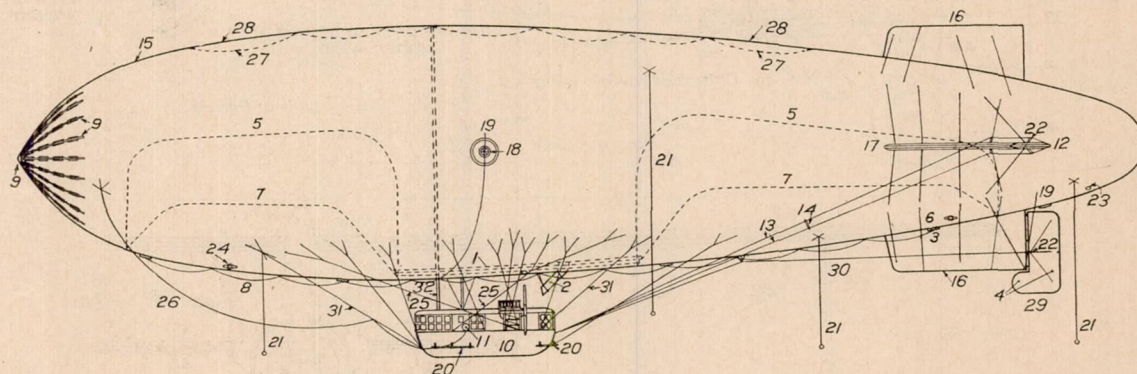


FIG. 1.—Airplane



- |                             |                               |  |
|-----------------------------|-------------------------------|--|
| 1-Air duct                  | 14-Junction piece             | 28-Suspension lines                      |
| 2-Air opening into ballonet | 15-Lobe, lateral; stabilizer  | 29-Tie patch for manometer tube          |
| 3-Air scoop                 | 16-Lobe, vertical; stabilizer | 30-Tie patch for rip cord and valve line |
| 4-Appendix manhole          | 17-Manometer tube attachment  | 31-Tie patch for internal valve line     |
| 5-Automatic valve rigging   | 18-Mooring bands              | 32-Toggle                                |
| 6-Ballonet                  | 19-Mooring ropes              | 33-Towing or traction cable              |
| 7-Ballonet deflation hole   | 20-Rip cord                   | 34-Tube cover                            |
| 8-Ballonet diaphragm seam   | 21-Rip cord gland             | 35-Valve adjusting gland                 |
| 9-Basket                    | 22-Rip panel                  | 36-Valve cord attachment pyramid         |
| 10-Deflation sleeve         | 23-Supply tube                | 37-Valve gland                           |
| 11-Gas valve                | 24-Supply tube check valve    | 38-Valve hood                            |
| 12-Hand valve line          | 25-Supply tube discharge tube | 39-"V" wires (steel)                     |
| 13-Handling lines           | 26-Suspension band            | 40-Winch suspension                      |
|                             | 27-Suspension bar             |  |

FIG. 2.—Kite balloon



- |                        |                                   |                            |                          |
|------------------------|-----------------------------------|----------------------------|--------------------------|
| 1-Air pipe to ballonet | 9-Bow cap and stiffeners          | 17-Fin, horizontal         | 25-Martingales           |
| 2-Air scoop            | 10-Car                            | 18-Gas manhole             | 26-Mooring line          |
| 3-Air valve            | 11-Drag rope stowage              | 19-Gas valve               | 27-Rip cord              |
| 4-Balanced surface     | 12-Elevator (balanced)            | 20-Hand rail               | 28-Rip panel             |
| 5-Ballonet             | 13-Elevator control lines         | 21-Handling lines          | 29-Rudder (balanced)     |
| 6-Ballonet manhole     | 14-Elevator control line fairlead | 22-Horn (rudder, elevator) | 30-Rudder control lines  |
| 7-Ballonet seam        | 15-Envelope                       | 23-Inflation sleeve        | 31-Suspension line, car  |
| 8-Ballonet valve cord  | 16-Fin, vertical                  | 24-Inspection window       | 32-Valve operating lines |

FIG. 3.—Nonrigid airship

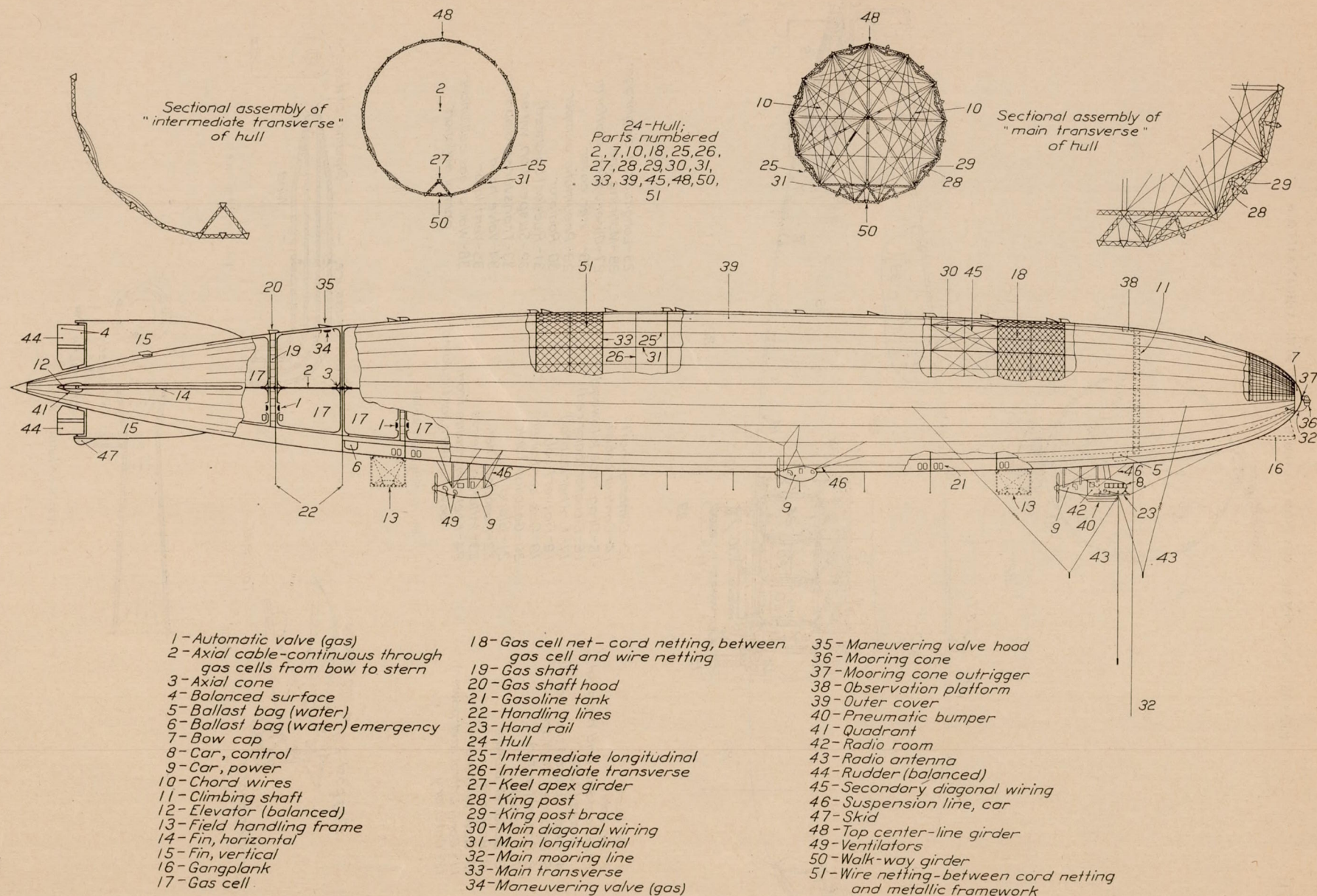
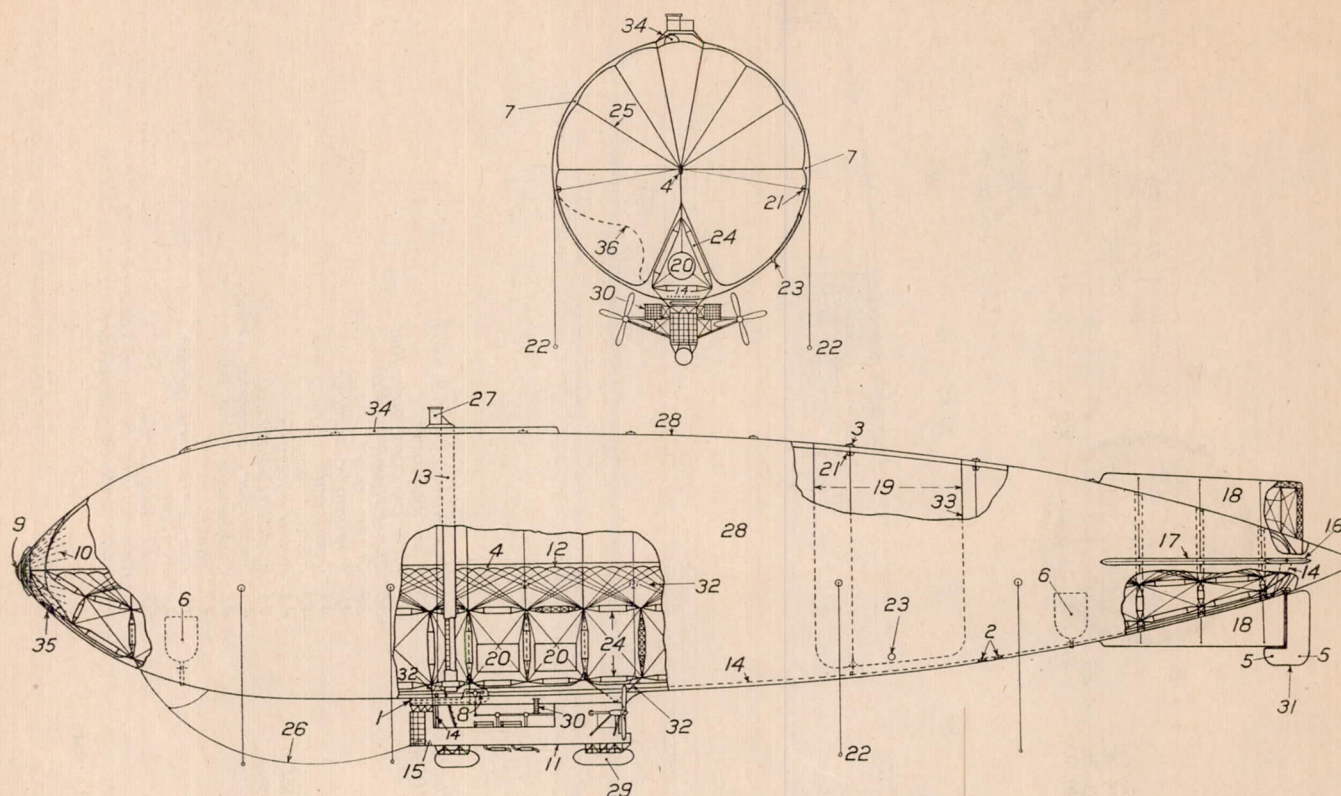


FIG. 4.—Rigid airship



- 1-Air duct
- 2-Air valve
- 3-Automatic and manual valve (gas)
- 4-Axial suspension band
- 5-Balanced surface
- 6-Ballast (water)
- 7-Ballonet
- 8-Ballonet blower
- 9-Bow cap
- 10-Bow stiffeners
- 11-Car (control and power)
- 12-Catenary

- 13-Climbing shaft
- 14-Control cables
- 15-Drag rope (stowage)
- 16-Elevator (balanced)
- 17-Fin (horizontal)
- 18-Fin (vertical)
- 19-Gas container
- 20-Gasoline tank
- 21-Gland
- 22-Handling lines
- 23-Inflation sleeve
- 24-Keel, continuous from bow to stern (articulated)

- 25-Longitudinal diaphragm
- 26-Mooring line
- 27-Observation platform
- 28-Outer cover
- 29-Pneumatic bumper
- 30-Radiator
- 31-Rudder (balanced)
- 32-Suspension wires
- 33-Transverse diaphragm
- 34-Valve hood
- 35-Ventilator
- 36-Wall of gas cell under partial deflation

FIG. 5.—Semirigid airship

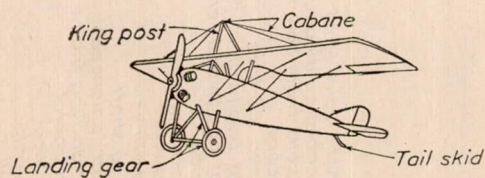


FIG. 6.—Tractor monoplane

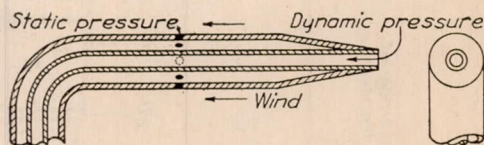


FIG. 7.—Pitot tube

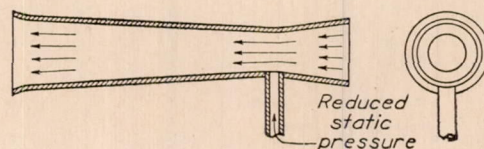


FIG. 8.—Venturi tube

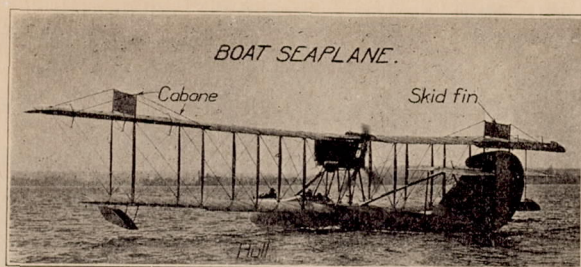


FIG. 9.—Boat seaplane

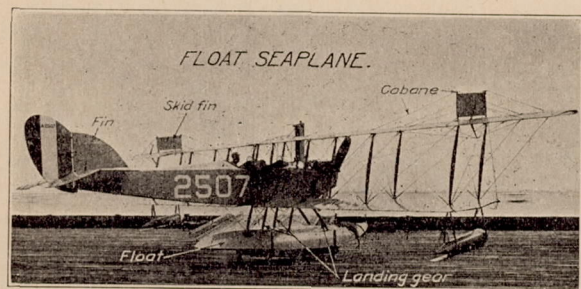


FIG. 10.—Float seaplane

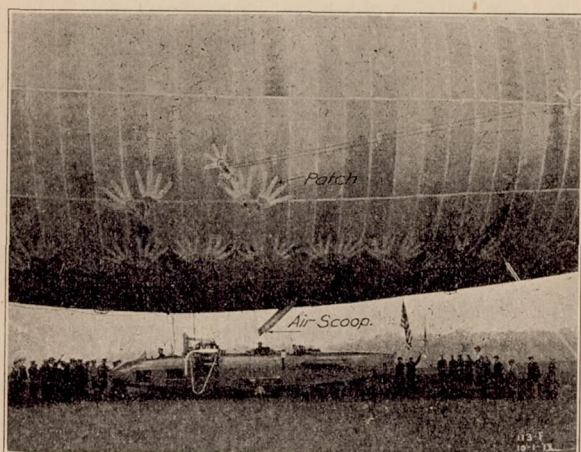


FIG. 12.—Air scoop and patch

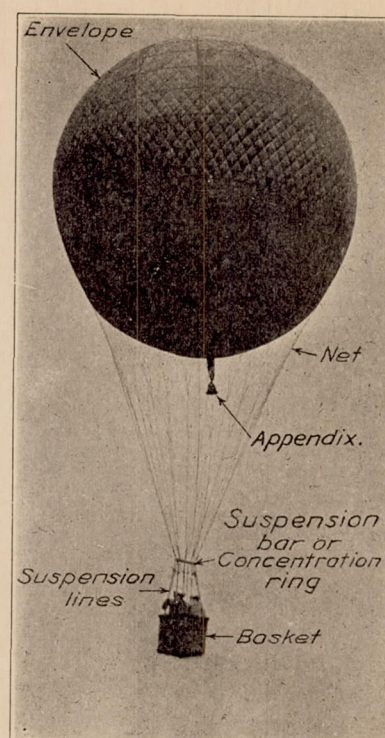


FIG. 11.—Free balloon

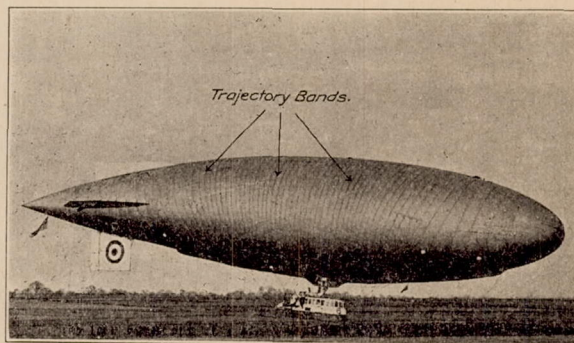


FIG. 13.—Trajectory bands

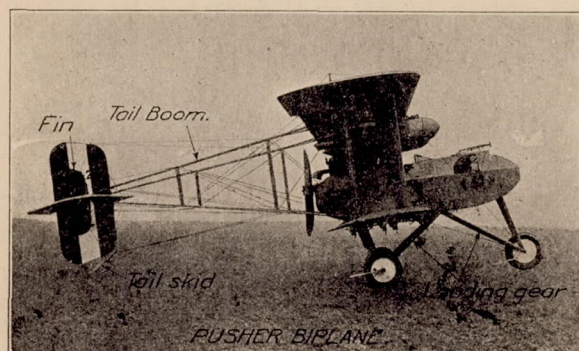


FIG. 14.—Pusher biplane

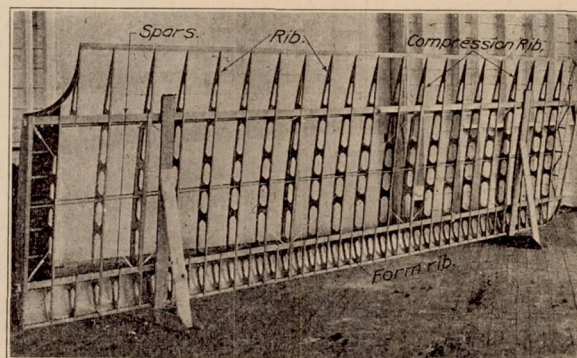


FIG. 15.—Skeleton of wing